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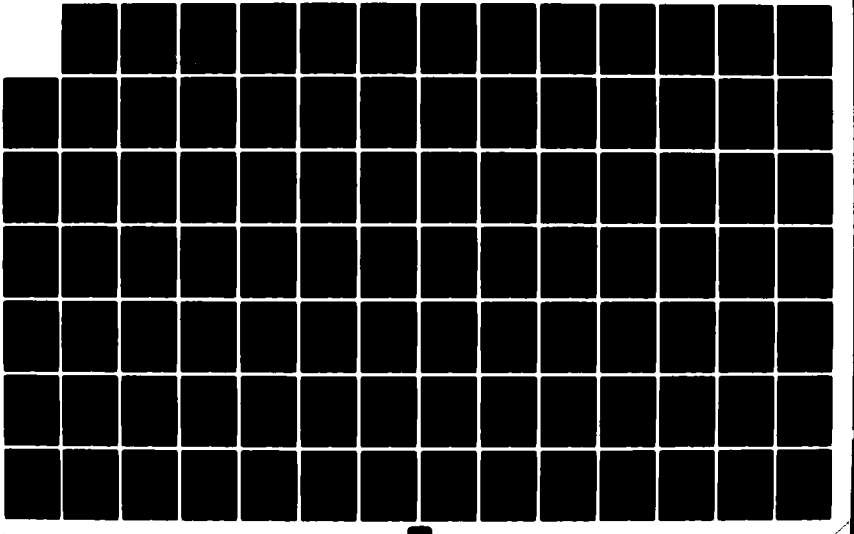

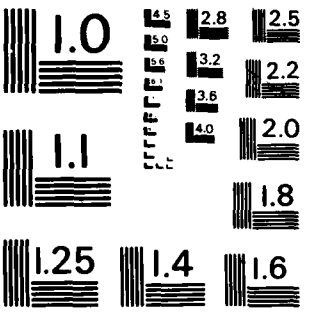

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A RAND NOTE

AURA USER'S MANUAL: VOL. II,
DATA INPUT AND SAMPLE PROBLEM

Robert Shishko, Milton Kamins

June 1983

N-1988-MRAL

Prepared for

The Office of the Assistant Secretary of Defense/Manpower, Reserve Affairs and Logistics

Adapted for Ground Forces Applications from the TSAR User's Manual by D. E. Emerson

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AURA (Army Urit Readiness/Sustainability Assessor) is a Monte Carlo discrete-event simulation ncdel intended for analyzing the interrelaticns amonq the resources asscciated with a set of combat units, and the capability of those units to generate ccmbat missicns in a dynamic, rapidly evolvinq wartime environment. This volume is the second of twc beinq prepared as a User's Manual for AURA. It discusses the irput requirements, procedures, and fcrmats, and provides a sample problem based on a hypothetical Army combat vehicle. These detailed discussions provide the cnly ccmplete explanations for some of the numerous control options available with AURA and must be considered mandatory reading for potential AURA users. The sample problem illustrates an AURA data base and the varicus outputs available with AURA. Vclume I of this series describes the capabilities and processing logic of the model.

PREFACE

This Note is one of five documents that collectively describe the AURA computer model, which can be used to assess the effect of resources on the mission-generation capabilities of combined arms units. AURA is an adaptation of the TSAR model developed by D. E. Emerson at The Rand Corporation under Project AIR FORCE sponsorship. This adaptation was carried out under a project for the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) entitled "Relating Resources to the Readiness and Sustainability of Army Units."

The Army Unit Readiness/Sustainability Assessor (AURA) model provides an analytic context within which a variety of support improvements may be tested. Alternative maintenance and supply doctrines, manpower policies, improved battle damage and recovery capabilities, and increased stock levels for parts and equipment, as well as concepts for improved theater-wide resource management, can be examined for their effect on mission generation.

The present Note provides a full description of the input data to be used in the AURA model, as well as a simplified problem involving a hypothetical Army vehicle. Companion Rand documents relating to AURA and AURA-compatible models include:

- R-2769-MRAL, *Relating Resources to the Readiness and Sustainability of Combined Arms Units*, December 1981.

- N-1460-AF, *TSARINA: User's Guide to a Computer Model for Damage Assessment of Complex Airbase Targets*, July 1980.

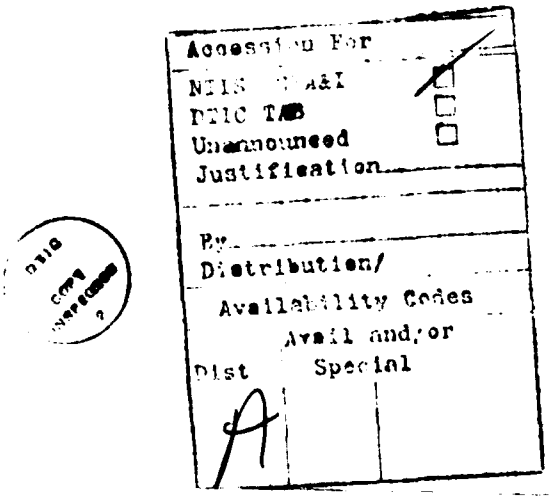
- N-1987-MRAL, *AURA User's Manual: Vol. I, Program Features and Interactions*, June 1983.

- N-1999-MRAL, *AURA Applications: Division-Level Transportation and Selected Spares Issues*, forthcoming.

ABSTRACT

AURA (Army Unit Readiness/Sustainability Assessor) is a Monte Carlo discrete-event computerized simulation model intended for analyzing the interrelations among the resources associated with a set of combat units, and the capability of those units to generate combat missions in a dynamic, rapidly evolving wartime environment.

This volume is the second of two being prepared as a User's Manual for AURA. It discusses the input requirements, procedures, and formats, and provides a sample problem based on a hypothetical Army combat vehicle. These detailed discussions provide the only complete explanations for some of the numerous control options available with AURA and must be considered mandatory reading for potential AURA users. The sample problem illustrates an AURA data base and the various ouputs available with AURA. Volume I of this series describes the capabilities and processing logic of the model.



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ACKNOWLEDGMENTS

Our ability to adapt an existing large simulation model to represent Army combined arms operations depended heavily on the patient and cheerful cooperation of a substantial number of Army officers and enlisted personnel at many locations in the United States and Europe. We are also indebted to a number of our Rand colleagues, particularly to Donald Emerson for allowing us to use the TSAR User's Manual as the basis for this Note, and for his patience in clarifying for us the subtler points in his original manuscript; to Robert Paulson for his data development assistance; and to Patricia Berger for implementing many of the program changes required. The timely completion of the documentation was ensured by the capable efforts of Barbara Urwin, Linda Freeman, and Mary Jane Digby.

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XVI. INTRODUCTION

Volume II of the User's Manual is intended primarily for those responsible for preparing input materials and for operating the AURA computer simulation model.

AURA is a Monte Carlo discrete-event simulation model intended for analyzing the interrelations among the resources associated with a set of combat units, and the capability of those units to generate combat missions in a dynamic, rapidly evolving wartime environment. On-vehicle maintenance tasks, parts and support equipment repair jobs, munitions assembly jobs, and facilities repair tasks can be simulated for each of up to 63 operating units, as well as intratheater transportation, communication, and resource management. Asset accounting for each of 11 classes of resources, and for each type within each class, permits assessment of a broad range of policy options that could improve the efficiency of resource utilization on a corps or theater-wide basis.

An important objective in the original design formulation of TSAR, AURA's parent model, was to achieve a sufficiently high speed of operation that the extensive (often trial and error) sequence of runs so frequently necessary in research and analysis would be economically practical.[1] Adaptation of existing models (e.g., LCOM, SAMSOM) was rejected for several reasons, including the extent of the modifications that would have been required and the prohibitive costs that would be associated with their use for problems of the size that were contemplated. The initial phase of development was designed to test the hypothesis that speed would be improved if custom-tailored list processing techniques were created using the widely available FORTRAN language, rather than using standard simulation language packages, and if full advantage were taken of the large amounts of directly accessible computer memory that are now available. The resultant custom-designed TSAR/AURA program achieves a substantially higher speed than previously developed simulation models of equivalent and lesser complexity.

[1] At present, the TSAR and AURA source codes are virtually the same, though certain program dimensions are different, and all output formats in AURA use terminology more familiar to Army personnel.

In its current formulation, AURA makes no intermediate use of auxiliary high-speed storage units (e.g., disks, tapes) except for storing the initial conditions for multiple trials. To constrain the substantial computer storage requirements generated by this design feature, all but a handful of the program variables and array elements occupy only two bytes of core, and many of the array elements are packed with two and sometimes three, four, or even five pieces of information.

AURA now consists of 126 subroutines and 8 functions (with 225 entry locations); the source code consists of over 40,000 card images, exclusive of that required for the common statements. Without the space required for the data storage arrays, approximately 500K bytes are required for the program, when the input-related subroutines are overlaid. If certain features are not to be used (e.g., enemy air/artillery attack, corps or theater management of vehicles or other resources, and parts initialization) this requirement can be reduced by overlaying the subroutines associated with the unused features. Useful applications of AURA involving an entire combined arms brigade may require 1000K bytes for data storage, but other applications may require only 50 to 100K bytes for storage. The auxiliary SIZE.AURA.STORAGE program quickly estimates the user's requirements. All data that would be needed to resume operation in the event that processing was interrupted (as might be done, for example, if one wished to adapt the program for interactive operation) are in COMMON statements.

OUTLINE OF MATERIALS

The materials in this volume and the extensive comments included in the AURA source code are designed to help those responsible for preparing input materials and for operating AURA. The next section outlines the classes of resources that AURA can deal with, and discusses certain built-in numerical constraints that the user must observe. Section XVIII outlines the procedures that are to be used in restructuring AURA storage space for each user's special requirements. Since essentially all data are retained in core during execution, core management discipline will dictate occasional program redimensioning, when the character of the situation to be simulated changes greatly.

Section XIX is the key source of information for the use of AURA; it is the only location in which all of AURA's features and controls are explained. Section XIX provides extensive discussions and explanations of the appropriate data entry procedures for the 50-plus data entry formats that are used with AURA. Each discussion presents a copy of the data input format and sample entries to illustrate the use of each form. When options exist, each is illustrated. Section XX describes a sample data base for a single hypothetical Army combat vehicle.

DATA REQUIREMENTS

AURA input data requirements naturally depend upon the level of detail at which the simulation is to be conducted and the features that are to be used. Many sources are available that can contribute to these requirements. Of the different types of data, probably the most complex and difficult to obtain are those that define the demands and resources for unscheduled maintenance and parts repair for different types of vehicles. Fortunately many of these data are collected on a regular basis for various purposes by the Army, including initial spare parts provisioning and manpower authorization studies. A companion document to be issued in the near future will illustrate how such data can be extracted from Contingency Maintenance Allocation Charts (CMACs) for combat and tactical vehicles.

XVII. RESOURCE LIMITATIONS

Eleven distinct classes of resources may be monitored using AURA, but only vehicles are mandatory. The 11 classes of resources, the number used to identify each class, the arrays in which their status is stored, and the restrictions on the numbers of types and the numbers of each type are:

Resource Class Name	Number	Storage Array	Maximum Number of Types	Number Per Type Per Unit	Maximum Number Shipped Per Lot
Vehicles	8	ACN	9	999	250
Crewmen		PILOT	1 per veh. type	--	250
Shelters		BASES	1 per unit	999	--
Maintenance personnel	1	PEOPLE	320	320	250
Support equipment	2	AGESTK	99	127	250
Parts (LRU, SRU)	3	PARTS	3199	320	250 250
Munitions (assembled and unassembled)	4	MUNSTK	99	32000	6250 6250
Accessories	5	TRAP	99	32000	6250
Building materials	6	MATERL	99	32000	250
POL	7	POLSTK	1	32000	250 × (10^2)
Other facilities	9	FACLTY	250	1	--

Vehicles, crewmen, facilities, and reparable spare parts are monitored on an individual basis; all others are handled in more aggregated terms. The level of detail varies from that maintained for a vehicle--potentially several dozens of items of information--down to a simple tally of the numbers of shelters and the amount of POL available at each unit.

Although not explicitly treated as a resource (except insofar as physical damage thereto may be reflected in the FACLTY array), the work-centers, or shops, in each unit are the entities around which vehicle maintenance activities and the parts and support equipment repair activities are organized. Except for combat engineer resources, all ongoing, interrupted, and waiting jobs are locatable using the pointers stored in the SHOPS array; that array stores 26 data elements for each shop on each unit. AURA storage arrays are sized for a maximum of 30 shops, the last five of which are reserved for premission tasks and weapons assembly jobs.

The subroutines that prepare resources for intratheater shipment (SHPRES) and that receive intertheater and intratheater shipments (DOSHIP) are written to accommodate maintenance personnel, support equipment, parts, munitions, accessories, building materials, and POL. However, the only theater resources that are actually transferred within the theater using the current theater management logic are maintenance personnel, support equipment, and parts; all resources may be received from CONUS. Similarly, the program logic permits vehicles and spare crewmen to be moved to the theater from CONUS, and allows vehicles to be moved from one unit to another within the theater for maintenance and to be directed to return to a different unit than the one from which they were last sent on a combat mission.

XVIII. DIMENSIONING AND REDIMENSIONING

For many study applications it will be appropriate and necessary to redimension various portions of AURA's data storage arrays. All the arrays are listed below, and their dimensions are defined in terms of variables that are in COMMON. When the user's data demands a different amount of space for storage, or if the problem can be projected to require a substantially different amount of space for queuing the internally generated event data (e.g., tasks in process, interrupted, and waiting), the dimension can be changed in all necessary locations with a single text editor command.

A special auxiliary program called SIZE.AURA.STORAGE has been written to facilitate the necessary preparatory steps for redimensioning AURA. All storage arrays are located in one of 25 different COMMON statements, and these statements are inserted into the appropriate subroutines by referring to their individual locations in storage; by this means, only one change is required to redimension any given array in all the locations in which it ultimately appears. This process is outlined in detail in the comments in the INIT subroutine, and in the SIZE.AURA.STORAGE program.

The dimensions of all arrays in all COMMON statements are shown in the list below using the variable that the program associates with each dimension. The appropriate value for many of the array dimensions will be uniquely identifiable by the nature and data of the user's problem. However, the dimensions needed for the data generated dynamically during the simulation are not knowable, a priori. Some experience with the particular application will be needed if space is to be conserved and data (tasks, jobs, shipments, etc.) are not to be lost; OVERFL permits the user some flexibility for dealing with this problem. The temporary queues in subroutine DELAYS may also overflow, but a warning to that effect is printed. Arrays with deterministic requirements are in the first of the following lists; the queues and heaps are listed second.

Many of the arrays are dimensioned by MAXM, MAXT, and MAXB--i.e., the maximum numbers of missions per vehicle type, vehicle types, and units. These dimensions are abbreviated here as M, T, and B. The limits for these dimensions are 5, 9, and 63.

DETERMINISTIC DIMENSION REQUIREMENTS

ACA(3,M,T,B)
ACDATA(25,T)
ACMDTA(20,M,T)
ACN(MAXACN,40)
ADELAY(24,2,B)
AGEREP(NOAGER,6)
AGERPT(NOAGE,8)
AGERQT(NOAGE,M,T)
AGESTK(NOAGE,3,B)
AIDALT(T)
AISDTA(NOSTAT,5)
AISUSE(NOSTAT,5,B)
ALERT(6,M,T,B)
ALTAGE(NOAGE,3)
ALTPEO(NOPEOP,3)
AQPEOP(NOPEOP,5)
ATTACK(LTHATT,5)
AVGP(3,30,B)
AVGREP(25,T)
AVGSHP(B)
AVGTSK(25,T)
BASES(50,B)
BORROW(NOUSER,2)
BPARTS(15,T,B)
BSOR(B)
CANCEL(5,T,B)
CANFLY(3,M,T,B)
CANNTM(NOPART)
CARGO(NCARGO,2)
CEPRTY(NOFAC)
CERQTS(8,NOCE)
CHCKED(NOPART)
CIRFTM(24)
CKFILL(T)
CONFIG(NOCONF,8)
CONUS(NOCONS,2)
COSTS(NOPART)
CSTOCK(NOPART,2)
CTPEO(NOPEOP)
CTPEOP(NOPEOP,5)
DAMAGE(NOITEM,2)
DEPOT1(NOPEOP)
DEPOT2(NOAGE)
DEPOT3(NOPART)
DEPOT4(NOMUN)
DEPOT5(NOSTAB)
DEPOT6(NOMATL)
DEPOT8(T)
FACDAM(NOFAC,6)
FACLTY(6,NOFAC,B)
FILLER(T,2)
FRACBS(NOPART,B)
FRACJB(NOFAC)
GTLMT(NOPART)
INPIPE(NOPART,B,2)
IPIPE(NOPART,2)
HURRY(B,5,2)
ITEMS(B)
JOBDTA(20,2)
JOBPR(2,T)
LANDNG(B)
LATERL(B)
LISTIN(LTHLST)
MATERL(NOMATL,B)
MAXOFF(2,T)
MUNRQD(NOMUN,M,T)
MUNRQT(4,NOBILD)
MUNSTK(NOMUN,4,B)
NOR(B)
NORHRS(B)
NSTAT(NOSTAT,2,B)
OFFBSE(2,50,2,T)
OFFCOB(NOPART,T)
OFFMOB(NOPART,T)
OUTAGE(2,NOAGE,B)
OUTFAC(2,NOFAC,B)
OUTMAT(2,NOMATL,B)
OUTMUN(2,NOMUN,B)
OUTPER(2,NOPEOP,B)
OUTPOL(2,B)
OUTPRT(2,NOPART,B)
OUTSHP(6,30,B)
OUTTRP(2,NOSTAB,B)
OUTPT1(5,6,M,T,B)
OUTPT2(3,3,25,B)
OUTPT3(2,M,T,B)
OUTPT4(2,30,M,B)
OUTPT5(5,30,B)
PARTRQ(NOPART,T)
PARTS(NOPART,5,B)
PEOPLE(NOPEOP,7,B)
PEORPT(2,NOPEOP,B)
PEORQT(NOPEOP,M,T)
PERIOD(20,3)
PILOT(5,NOCREW)
PILOTS(5,T,B)

POLICY(NOPART,B,2)	POLSTK(B)
+PRTCRT(NOPRT,2)	+PRTLST(NOPRT)
PRTRPT(4,NOPART,B)	PRTRQ(NOPART,2,T)
PTZ(M,T,B)	RECORD(NSCROL,3,MAXREC)
REDUCE(B,5,2)	REFILL(2,9)
RELIMP(33,5)	REPALT(NOREPA,4)
REPORT(NOREPT,4)	REPRQT(NOREP,8)
RINDEX(4,9)	ROOTS(NOPART,T)
SAVE(B,5,2)	SCLP(5,M,T,2)
SCLRQT(NOSCL,9)	SEEDED(10)
SEEDS(10)	SHIP(NOSHIP,7)
SHIPSC(NOSHP,3)	SHIPTM(B,B,3)
SHIPTO(B,20,2)	SHOPAG(NOAGE)
SHOPEO(NOPEOP)	SHOPRQ(30,M,T)
SHOPS(26,30,B)	SHORT(NOPART)
SHPORD(50,T,B)	SHPT(B,B,4)
SHPTSK(3,NOTASK,25,T)	SICK(NOPEOP)
SORCAP(T,B)	SORDEF(16,3,M,T,B)
SORTHR(24,B)	SPARE(2,M,T,B)
SRFRAC(B,2)	STAFF(NOPEOP,2)
START(6)	STOP(6)
SVEFLT(12,5)	TCONF(M,M,T)
TEMPF(50,4)	THDATA(4,3)
TOCIRF(NOPART,2)	TOTALS(NOPART,B,3)
TPART(EXTPRT,3,B)	STAB(NOSTAB,8)
STABRQ(2,3,T)	TRAY(NOPART)
TRAYS(NOTRAY)	TRAYST(NOTRAY,2,B)
TRYFLY(6,T,B)	TSKALT(NOTSKA,5)
TSKCRT(99,5)	TSKPR(25,T,3)
TSKRQT(NOTSK,15)	WXDATA(WXDAYS,2,B)
XMIT(4,B)	ZPRTRQ(NOPART)
ZTASKS(5,T,B)	

+NOPRT must at least equal the highest part or LRU number.

DYNAMIC DIMENSION REQUIREMENTS

Queues and Heaps

BACKLG(5,LLQ)	BUILDQ(LBQ,10)
CEJOBQ(LTHCEQ,9)	CHANGE(NOCHG,5)
DEFTSK(LDT,4)	FLTRQT(LFQ,10)
INTTSK(LIQ,10)	LIMBO(NLIMBO,6)
NORQ(NNOR,3)	PRDFLT(MAXPER,5)
REJOIN(NJOINT,2)	
REPQ(LRQ,11)	RESUPP(LGQ,5)
RQDTSK(LNT,2)	SHIPQ(NOPKG,3)
TASKQ(LTQ,16)	WAITSK(LWQ,13)

XIX. DATA ENTRY

The data requirements for AURA are substantial, and it is mandatory that the user observe the specifications outlined here. Even though AURA checks input data for a considerable number of possible errors, possibilities for error remain and great care should be exercised with data entry. Careful adherence to the data-entry-form specifications is advised.

Data entry is accomplished using the (approximately) 50 distinct card formats illustrated in this section. With few exceptions (to be outlined) all cards are read with the same format (I2,I3,15I5) and all data must be right-adjusted. The number of the Card Type appears in the first two-column field. The second field (cols. 3-5) is occasionally referred to as the "J" field. Although there are only a few constraints on the actual order in which the cards are arranged, data organization will generally be simplified and fewer errors incurred if the various card types are entered in numerical order.

The proper organization of a card deck of AURA input data is illustrated in Fig. 1. As will be noted, several special control cards are needed, in addition to the formatted input data cards. The first input card controls which of the numbered input cards are to be listed as a part of the printed record of the job. That card is followed by Card Types #1 through #4, including whatever comment cards the user has added after Card Type #1; these cards define the user's selection of the primary control data, as will be described shortly. Descriptions of the various kinds of jobs, the quantities of resources available at each of the operating units, specifications for the transportation and communications systems, etc. are entered next using Card Types #5 through #49. The end of this large set of input cards is designated with a Type #99 Card; and following that is another special card that controls which, if any, of the initialized contents of the data storage arrays are to be listed in the printed record of the job.

The mission demand data (Type #50 Cards) and any transportation schedule changes (Type #60 Cards) conclude the input data deck. These cards may be arranged in several groups that are to be read at different times during the simulation; the last of the first group of such cards is denoted by another Type #99 Card that specifies (in the "J" field) the day of the simulation when the next group of mission demand data are to be read. As noted in Fig. 1, each subsequent group of mission demand data cards is also terminated with a Type #99 Card and each of these cards must specify how many simulated days are to elapse before additional mission demand data should be input.

Most data for AURA are stored as half-words (two-byte integers), and many of the half-words are packed with 2, 3, 4, or 5 pieces of data. Since AURA was designed to be compatible with a 32-bit-word machine (e.g., IBM), the largest integer that may be stored in a half word is $2^{15} - 1$. The number 32750 is occasionally used in the code to denote "infinity" and the user must exercise care that no larger number is entered in any of the five-column fields. (When 50,000 units of fuel were inadvertently provided a unit in an early test run, the quantity was recorded as negative, and all missions were canceled.)

One consequence of these data storage features is that time is subdivided into three-minute increments referred to as TTU--TSAR(AURA) time units--and the maximum length of time that should be simulated per trial is 65 days; to generate a single history of greater length, it is necessary to use the EXTEND feature (see Card Type #1).

The Card Type descriptions that follow each include (a) the entry form formats,[1] (b) a description of the nature of the data requirements, and (c) comments on the occasional nonstandard formats. As will be noted in many places on the card formats, the data are sometimes packed automatically on input--i.e., when two or more data items are read in the same five-column field.

Although AURA will be compatible with machines that use more than 32 bits for a word, it will not function properly on a machine that uses a shorter word. For those installations at which half-words (integer*2)

[1] Master copies of these entry forms will be made available to those who obtain a tape copy of the AURA program.

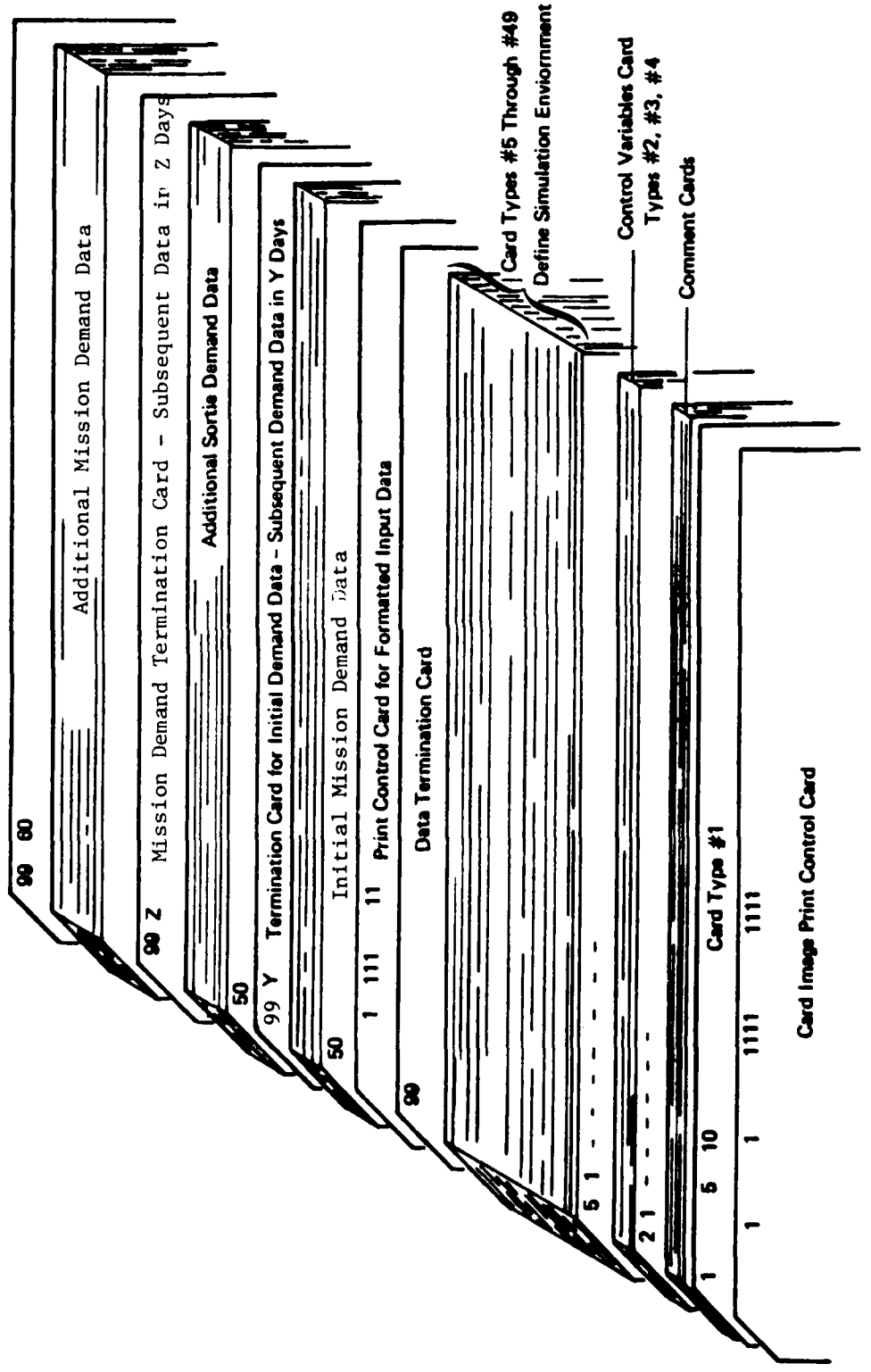


Fig. 1 — Organization of AURA input data card images

are not available, data storage requirements will be nearly doubled, but no difficulties should be encountered with the "packed" data.

Each of the shops and each of the sets of resource requirements (e.g., tasks, repairs, combat loadings, and their alternatives), as well as each of the various types of the various resources, are identified within the model by a number. That number also designates the column of an array in which the data regarding that entity are stored. The user must:

- Name each such element that is involved in his problem with a number,
- Assure that that number is no greater than the size of the storage array for that class of information and that only one member of that class has that number,
- Maintain lists (dictionaries) of such definitions, external to the program, to avoid confusion,
- Assure the accuracy of all cross-references within the input data that involve these user-specified entity names.

AURA PRIMARY CONTROL DATA

Card Types #1 through #4, shown in Fig. 2, provide for entry of key AURA control variables. These cards should be at the beginning of the user's card deck and should be entered in numerical order. All data must be right-adjusted. The many control variables that the user sets with Card Types #1 through #4 either define operating conditions for the simulation, activate (or deactivate) AURA's optional features, or delineate the user's choice among optional operating modes.

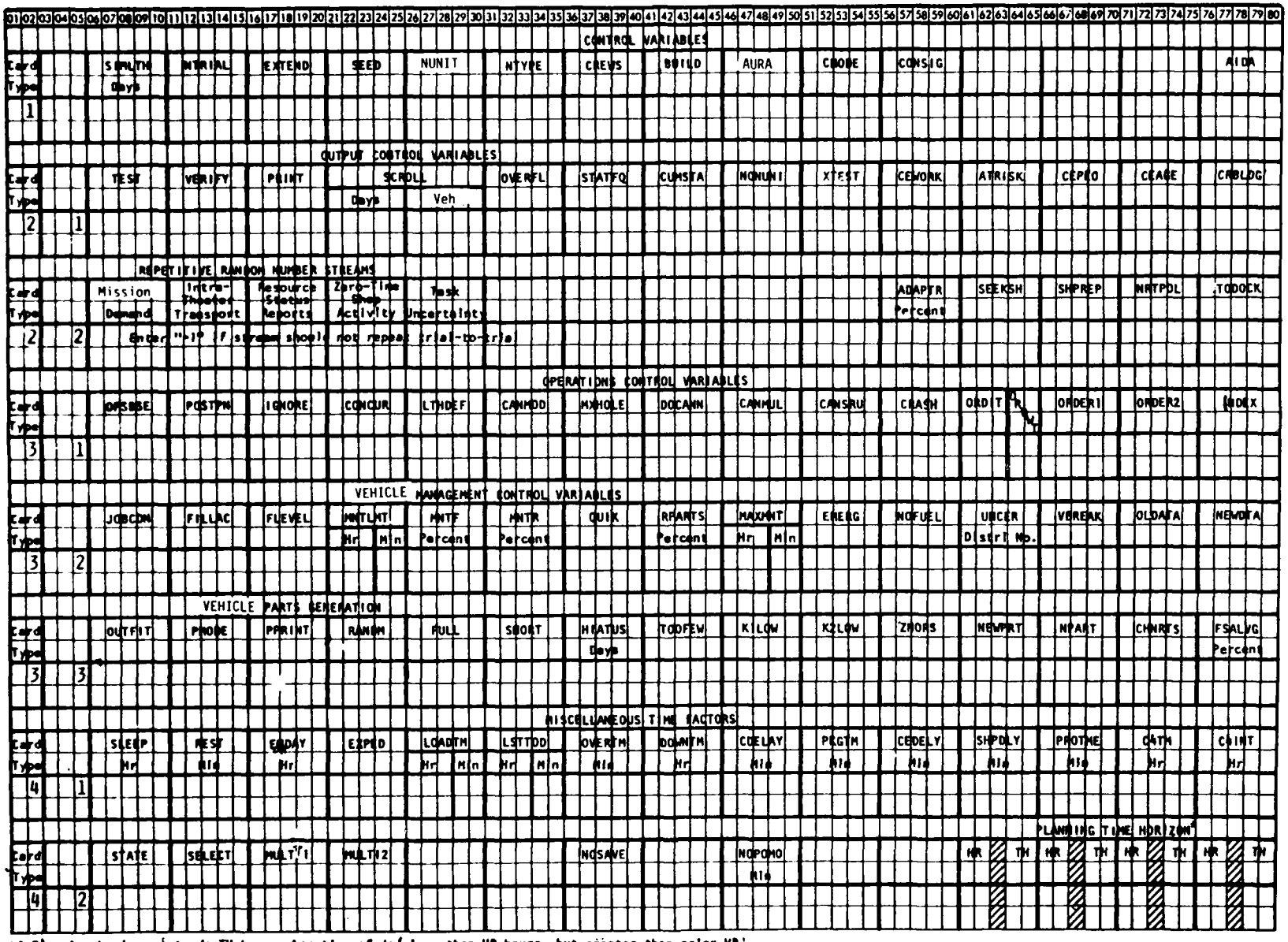
Two special convenience features may be invoked with Card Types #1 and #2/1. If the user desires to have his output headed by N lines of descriptive material, the number N is entered in columns 3-5 on Card Type #1, and N card images are then mandatory before Card Type #2/1 is read; there are no format restrictions for these descriptive materials.

The first control variable on Card Type #2/1 is TEST. A null entry is appropriate for normal operation, but a variety of intermediate debugging data may be obtained by initializing this variable. For positive entries between 1 and 15, an ever increasing amount of such data will be printed for all trials. If the entry is -1, the volume of such output can be reduced by limiting debugging output to one, or up to six, specific periods of simulated time during a specific trial: When this is done, a single card image must immediately follow Card Type #2/1, which specifies the trial, the time intervals, and the value for TEST during those time intervals. This card is read as I3, I2, 12I5; the order of data entry is TTRIAL, TEST, START(1), STOP(1), . . . , START(6), STOP(6). If the trial number (TTRIAL) is not specified, the output will occur during the first trial. The times are to be entered in AURA time units (i.e., 3 minute time intervals); one to six time intervals may be specified and the intervals must be entered in the order of their occurrence.

Card Type #1

If J is not zero, J comment cards must follow this card

SIMLTH	Length in days of the period to be simulated.
NTRIAL	Number of repetitions of the simulation.
EXTEND	If unity, an NTRIAL simulation produces a single history NTRIAL × SIMLTH days in duration.
SEED	If set equal to a nonnegative integer, the operating system selects a reproducible value for the SEED of the random-number generator; if set to zero the SEED is selected by a random process.
NUNIT (NBASE)	Number of units that will actually operate combat or tactical vehicles as pacing items (may be less than or as great as MAXB).
NTYPE	Number of vehicle types to be used in the simulation (may be less than or as great as MAXT).
CREWS	Crewmen are accounted for when = 1; neglected if 0.



* Planning horizon extends TH hours when time of day less than HR hours, but greater than prior HR.

Fig. 2 — Primary control variables

BUILD	Switch; when unity, the munitions assembly features are activated.
AURA (TSAR)	If unity, resources are managed centrally; if set to 2 the highest numbered unit will act as a general support repair facility that does not operate vehicles as pacing items.
CMODE	When not zero defines the mode of operation for corps or theater resource management (see Section XI).
CONSIG	If zero, any parts that are shipped to the theater to replace condemned parts, and LRUs that were NRTSed to CONUS, are consigned to the unit of origin on return; if unity, all parts are consigned to the theater manager for distribution.
AIDA	Controls the interpretation of unit damage resource data; normally not to be specified by the user, but to be entered with the damage data.

Card Type #2/1

TEST — Controls internal debugging features. If > 0, diagnostic messages are printed for the entire simulation; if -1, a special card must follow defining the time intervals for the debug output.

VERIFY — Controls input data testing features. If = 1 or 2, limited tests are made on input; if = 3, each input card is checked by subroutine TESTER. The meaning of resulting error type numbers can easily be determined by reference to subroutine TESTER, where the variable "M" (the number of the error) is incremented for each test on each card. If ≥ 2, operation is terminated after initialization.

PRINT — Value controls content of simulation output (see Section XV).

SCROLL — Provides vehicle activity reports for the specified number of days for up to 24 vehicles, starting with the vehicle number specified.

OVERFL — Value controls simulation behavior if the dimensions of the arrays used to store internally generated data are exceeded:

When OVERFL = 0, simulation stops;
= 1, overflow noted and tallied;
= 2, overflow noted for first entry only tallied;
= 3, overflow tallied.

This feature must be used with caution because program behavior can become extremely erratic when certain types of records are discarded. In any event execution is terminated automatically at the end of any day if the cumulative number of discarded records is 20 or more.

STATFQ — The frequency, in days, with which the summary data regarding the average length of time for tasks and jobs, and the causes and lengths of the vehicle delays, are printed. If STATFQ = 0, these data are not collected or printed.

CUMSTA — Controls the cumulation of task and delay time data; when 0, data are cumulated separately for each trial; when 1, data are cumulated across all trials.

NONUNI — When unity, resource losses are determined by a sample from the binomial distribution; if zero, losses are

determined on a straight percentage, or expected value basis.

CEWORK — Switch; when unity, combat engineering resources are allocated to repair damage from enemy air/artillery attacks in accord with the priorities defined by the CEPRTY array.

ATRISK — When a shop facility, or all elements of a distributed shop, are damaged at the time of a subsequent attack, the resources assigned to that shop are assumed to have been relocated and to be invulnerable if ATRISK is zero; if ATRISK is unity, the damage is assessed as though operations were normal.

CEPEO — The number of types of personnel associated (exclusively) with combat engineering tasks.

CEAGE — The number of types of support equipment associated exclusively with combat engineering tasks.

CRBLDG — Unless combat engineering resources are sufficient to initiate repairs to all damaged facilities up to and including this priority, reconstruction tasks are pursued with secondary procedures using lesser resources.

Card Type #2/2

AURA provides ten distinct random number streams that are repeated from trial to trial. These streams can be disengaged only if the user enters a "-1" in the Nth field on Card Type #2/2 to disengage the Nth stream.

At this time, only five of the random number streams are used. The first random number stream (cols. 6-10) is used in the generation of AURA's vehicle mission demands; the second is used for selecting the intratheater transportation schedules; the third is for generating resource status reports; the fourth is for selecting the zero-time shop activity controlled by Card Type #42; and the fifth is used in generating "actual" task probabilities for unscheduled maintenance when UNCER is not zero. Random streams six (cols. 31-35) through ten (cols. 51-55) currently are available for additional applications.

AUXILIARY CONTROL VARIABLES

ADAPTR	NRTS policy for RR parts is changed when there are fewer LRUs than ADAPTR percent of the initial LRU stocks; they are shipped to a lateral resupply unit rather than nominal NRTS destination if the NRTS rate at that unit is lower than at the unit where the reparable was generated.
SEEKSH	When unity, another in-theater shop is sought for parts repair, when the nominal shop is closed by damage; useful when simulating several general support maintenance activities.
SHPREP	When not zero, all parts repaired at an operating unit are shipped to the unit that is selected with the SEND logic in the CONTRL subroutine, when (NMCS Vehicles - Required Parts) is greater than, or equal to, SHPREP.
NRTPOL	If unity, an LRU that requires an SRU that is unavailable and is not normally stocked, is NRTSed.
TODOCK	If unity, parts that are normally NRTSed to another unit, but can't be because no shipment schedule exists, are held for later lateral repair rather than being sent to CONUS.

Card Type #3/1

OPSBSE	Number of units that may initiate combat missions; excludes rear maintenance units and a general support repair facility, if any.
POSTPN	If zero, all unscheduled maintenance tasks must be accomplished before next mission; if = 1, tasks will be deferred (postponed) that are not critical for next mission.
IGNORE	If initialized to unity, all jobs that may be deferred for all missions are ignored.
CONCUR	If unity, battle damage repair jobs may be initiated concurrently with the first of the other unscheduled maintenance tasks; otherwise, the battle damage tasks are scheduled to be accomplished first.
LTHDEF	Unscheduled maintenance tasks whose criticality is greater than 66 may be deferred ("back-pocketed") for a maximum of LTHDEF missions.
CANMOD	Cannibalization mode (see Section V).
MXHOLE	The maximum number of "holes" that may be created on a single vehicle by cannibalization (default = 10000).
DOCANN	When DOCANN is greater than zero, parts for which the CANNTM is less than -1 may be cannibalized if the number of vehicles that require the part at the unit is greater than DOCANN.
CANMUL	Nominal task time when a part is cannibalized; expressed as a percentage of the nominal time for the task segment that specifies the part (default = 150 percent).
CANSRU	If not zero, the SRUs are stripped from one of two or more LRUs that are waiting for repair, when vehicles are NORS because of that LRU. At a GSRF, an LRU will be be similarly salvaged, if the total NMCS count in the theater is greater than or equal to the value of CANSRU.
CRASH	If not initialized, the mission length is extended such that the vehicle will recover when an available unit resumes operation; if initialized at 1 and all operating units are out-of-action, vehicles are captured during their misison.
ORDIT	Interrupted tasks and repairs are prioritized when

ORDIT = 1; FIFO if 0. See Sections V, VII, and XI for discussions of priority schemes.

ORDWT — Waiting tasks and repairs are prioritized when ORDWT = 1; FIFO if 0. See Sections V, VII, and XI for discussions of priority schemes.

ORDER1 — Threshold controlling theater response to parts shortages; responds only if (Enroute Parts + On-unit Reparables - Required Parts) is less than or equal to ORDER1. Response is increasingly restricted for ever lower values of ORDER1.

ORDER2 — Threshold controlling an operating unit's recourse to lateral resupply; seeks lateral resupply only if (On-unit Reparables - Required Parts) is less than or equal to ORDER2. (Reparables are assessed only if the shop is open and functioning.)

INDEX — A threshold used when checking repair jobs waiting at a GSRF; if exceeded as jobs are checked, the job is processed without checking for a higher priority job. The appropriate value to set will depend upon which of the two logics (SHOPRY = 1 or 2) is in use.

Card Type #3/2

These entries jointly control AURA's mechanisms for replacing lost and heavily battle-damaged vehicles and for transferring and/or augmenting vehicles with extended maintenance requirements.

JOBCON — Defines which jobs are to be accomplished when a vehicle is sent to a rear DS/GS maintenance unit:

If = 1, the maintenance scheduled for the rear unit includes all mandatory rear-unit tasks, all other required tasks, and all mission dependent deferred tasks that must be done in rear;
If = 2, above plus all mission dependent deferred tasks;
If = 3, above plus all deferred tasks;
If = 4, vehicle is returned to operating unit with all non-rear-unit tasks remaining.

FILLAC — Value controls use of filler vehicles:

If = 1, only vehicle losses are replaced from the filler force;
If = 2, vehicles transferred to the rear for battle damage repair are also replaced;
If = 3, any vehicle transferred to the rear is replaced;
If = 4, unit vehicles are augmented as for FILLAC = 2, and when a vehicle's local battle damage repair time is expected to exceed MAXMNT hours;
If = 5, unit vehicles are augmented for any of previous conditions and when a vehicle's unscheduled maintenance is expected to exceed MAXMNT hours.

FLEVEL — The value of FLEVEL affects the decision to augment any unit's vehicles, and controls the disposition of vehicles repaired at a rear unit and and those transferred from CONUS to the filler pool. To requisition an augmentee or to return vehicles from the rear:

If = 0, the number of surviving vehicles must be less than the number of authorized vehicles;
If = 1, the number of surviving non-battle-damaged vehicles must be less than the number of authorized vehicles;
If = 2, the number of surviving vehicles must be less than the unit's shelter capacity;
If = 3, the number of surviving non-battle-damaged vehicles must be less than the unit's shelter capacity.

When these conditions are not met, newly repaired and vehicles newly arrived from CONUS are consigned to the filler pool.

MNTLMT — Vehicles whose projected ready-to-go time exceeds MNTLMT hours are transferred to a rear-area unit for maintenance, if the time projected to ready the vehicle for a one-way trip is less than the time for the remaining maintenance, and if the constraints imposed by MNTF and MNTR (below) are also satisfied.

MNTF
MNTR — Candidates for transfer to a rear-area unit that are projected to require as much as MNTF percent of the time that would be needed at the rear-area unit to be readied for the transfer will be sent only if the estimated maintenance time at the rear-area unit exceeds MNTR percent of MNTLMT hours.

QUIK — Fillers used to replace combat vehicles transferred to the rear for maintenance are sent at the same time the combat vehicle initiates the transfer if QUIK is zero; if QUIK is unity, the filler is sent as soon as the combat vehicle has completed its mission and it is decided that it will be moved to the rear. The time for the trip is entered on Card Type #20/77.

RPARTS — When the automatic parts generation feature is used, RPARTS percent of the parts procured for the forward operating units will be placed at the rear-area maintenance unit(s); these are in addition to those that are transferred to the rear because of tasks that must be handled in the rear.

MAXMNT — If maintenance of a vehicle in a forward unit is projected to extend beyond MAXMNT hours, the unit will be augmented with a filler vehicle if FILLAC is 4 or 5, and a vehicle is available.

EMERG — Number of the emergency recovery unit; when specified will be used for vehicle recovery when the support areas at all other units have been closed; this unit may not be used for a GSRF.

NOFUEL — If unity, other premission tasks are prohibited when refueling is being conducted.

UNCER — When initialized with the number of a distribution from the TTIME subroutine, the "actual" unscheduled maintenance task probabilities used in the simulation are determined by selecting a value from that distribution, assuming the mean is the value entered by Card Type #7.

VBREAK — A switch. If zero or -1, unscheduled maintenance task probabilities are modified in proportion to the Card Type #44 entries. If unity, the basic probabilities are varied by shop and vehicle type as a function of achieved

mission rate. If set to -1 or +1, the basic values are used for estimating average shop task times, average resource requirements (in BSECAP), and initial parts stocks.

OLDATA — Base resource reports are generated when zero, and deferred initially while equal to unity.

NEWDTA — The time at which theater resource reports are to be initiated; only applicable if OLDATA is initialized as zero.

Card Type #3/3

The following control variables control the automatic generation of unit parts stocks, when that option is elected. (See Section VII.1.)

OUTFIT	Activates the automatic parts stock initialization.
PMODE	When unity, parts initialization uses Kamins' approximation; otherwise the Chapter 11 procedures from AFM 67-1 are used.
PPRINT	Controls output summaries of the initial stock levels and the parts pipelines (see subroutine IPARTS). When increased by 10, residual parts levels are listed after the delay statistics controlled by STATFQ. When increased by 20, the initial listing includes parts generated by IPARTS and those entered manually. When increased by 30, model execution is terminated at the end of the parts initialization computations just after the results of those computations have been organized in the format specified for the basic Type #23 Card. By storing card-image copies of just that portion of the output, the user has the needed #23 Type Cards available for subsequent use. When these cards are employed the user should check his selection for the value of the variable CHNRTS. This could be useful either to avoid repeating that calculation for a large number of runs, or to permit the user to combine parts computed in two different ways at a single unit.
RANDM	When unity, parts shortages and the location of parts in the pipelines are determined with samples from the Poisson approximation of a binomial distribution.
FULL	If unity, all parts are at the unit, none enroute, at zero time (identified as NOPIPE in Common).
SHORT	Parts shortfalls from "authorized" levels (percent) that result from system-wide shortages.
HIATUS	Delivery of parts in pipeline at the beginning of the simulation are to be delayed HIATUS days.
TOOFEW	The parts supply system is critically short of a percentage of the parts (equal to TOOFEW/10) because of insufficient numbers system-wide; part numbers are selected at random.
K1LOW	For parts that are "critically short" the actual stock

K2LOW — level, as a percentage of the nominal requirement, is selected at random in the range K1LOW to (K1LOW + K2LOW).

ZNMCS — When initialized to unity, parts that were not available to be placed in the pipeline during parts initialization because of shortages are obtained by removing them from a vehicle--i.e., by creating a NMCS condition. If ZNMCS is zero, a message noting the shortage is printed.

NEWPRT — If NEWPRT is unity, the parts initialization computations are repeated for each trial.

NPART — The number of the highest numbered LRU or SRU (default = NOPART).

CHNRTS — When spare parts generated by the automatic parts initialization logic are augmented using basic Type #23 Cards, the NRTS rates during the simulation will be the values in the POLICY array if CHNRTS is zero; if CHNRTS is unity the NRTS value on the basic Type #23 Card will be used.

FSALVG — If a vehicle is damaged by enemy air/artillery attack and is not reparable, FSALVG percent of the vehicle's spare parts not destroyed during the attack are salvaged and added to the serviceables.

Card Type #4/1

SLEEP	Minimum number of off-duty hours between shifts for crewmen.
REST	Minimum number of minutes between missions for a crewman.
ENDAY	End of the nominal operating day (used to control accomplishment of deferred maintenance) (hours).
EXPED	When initialized, the parts repair administrative delays are reduced to 1/EXPED of the nominal time, if there are no serviceables.
LOADTM	Nominal time to commence premission preparation for the day (hour-minute).
LSTTOD	Last time for commencing morning premission activity (used to limit expected time for deferred tasks) (hour-minute).
OVERTM	Number of minutes of overtime permitted.
DOWNTM	Parts may not be cannibalized from a vehicle with a ready-to-go time within "DOWNTM" hours.
CDELAY	The default time for cannibalization is one-half the related on-vehicle task time, plus CDELAY minutes.
PKGTM	Number of minutes required to package resources for an intratheater shipment.
CEDELY	Initiation of all reconstruction tasks is delayed by this number of minutes after an attack, to account for the preliminary delays involved in overcoming the disruptive effects of fires, roadway damage, etc.
SHPDLY	This delay is introduced to all on- and off-vehicle-related tasks, to account for the disruption following an attack. May also be used to simulate moving the support area.
PROTME	When insufficient vehicles are ready for a scheduled mission, and none can be found in the spare queue or a lower priority alert, a vehicle can be taken from another scheduled mission of the same or lower priority if the mission time is at least PROTME minutes later (default = 30 minutes).
C4TM	Time for initial theater resource review (hours).
C4INT	Time interval in hours between periodic theater resource reviews, subsequent to the initial review.

Card Type #4/2

STATE — If not zero, the state of each unit's capability to generate missions is computed daily (see Section XI.1). Use of a nonzero entry is generally reserved for cases that involve aircraft.

- > 1 — Unit-state-data used to select unit for diversion
- > 2 — Unit-state-data used to decide when vehicles return to owning unit (see MULTI1)
- > 3 — Vehicle unit assignment reorganized nightly when workloads are disproportionate (see MULTI2)

SELECT — When not zero, a daily summary of the assigned missions is prepared to facilitate selection of units for missions.

- > 1 — Summary data used when unit not specified
- > 2 — Summary data used for reallocating demands on units with attack delays.

MULTI1 — When a unit's projected mission-generation capability per assigned vehicle is greater by MULTI1 percent than that of the unit owning a vehicle, that vehicle is retained and not returned to the owning unit.

MULTI2 — Vehicle reassignment (STATE = 3) activated among units whose projected missions per available vehicle differ by more than MULTI2 percent.

NOSAVE — When NOSAVE = 1, records are not saved for parts that break after an attack has closed the shop that would normally process the repair, if the projected shop reconstitution time is not earlier than the end of the simulation.

NOPOMO — For standard U.S. organization, set to zero. When a nonstandard organization is specified, set to the average additional time required for on-vehicle tasks, if task times are for standard organization.

HR-TH — The time horizon used with the mission supply and demand projections may be changed from the default values with these entries; for example, if the entries are 8-12, 24-16 the time horizon would be 12 hours from 0 to 0800 and 16 hours from 0801 until midnight.

Card Type #4/3

SPARE1 ... SPARE9	Provides nine unassigned variables that are available in the BASIC labeled common statement for temporary use with user contrived logic.

SPECIFICATION OF TASK CRITICALITY AND VEHICLE STATUS

The importance of each vehicle maintenance task for each of the missions that each type of vehicle may be scheduled to undertake is specified with a two-digit number between 1 and 99. The capability of each particular vehicle to do a particular type of mission at any given time is also expressed with a number generated in the same way.

The interpretation of these numbers is specified in Table 1. When the task criticality or the combat ready status is specified by one of the numbers along the top, its status for a particular type of mission is recorded in the row corresponding to that mission. If the entry is 1, the task is critical for that mission, or the vehicle has a task that has been deferred that prevents that mission from being accomplished. If task criticality is 32, the vehicle may be moved under its own power; if it is 33, the vehicle is disabled until the task has been accomplished, or until it can be towed.

If a task may be deferred only until the end of the day, task criticality is increased by 33; if a task may be deferred only for LTHDEF missions, task criticality is increased by 66.

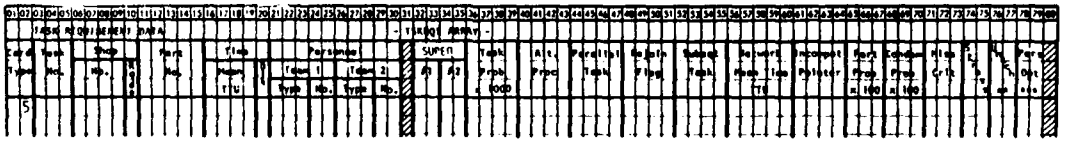
Table 1

CRITICALITY CHART

MISSION	TASK CRITICALITY or VEHICLE STATUS																														
										1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3
1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	1
2	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1
3	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	1
4	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

RESOURCE REQUIREMENTS DATA

Card Type #5



On-vehicle maintenance tasks are entered here: These can include scheduled maintenance, unscheduled maintenance, and battle damage tasks. As explained in Section V, the organization and sequencing of all vehicle maintenance tasks, other than battle damage repair work, are controlled independently for each vehicle type at each operating unit using Card Type #29. Tasks may be handled either individually or as collections of unscheduled tasks associated with the various work centers or shops. The first 24 shops should be used for such task collections; Shop #25 (the "ready-line" shop) and the premission Shops #27, #28, and #29 are handled somewhat differently (see Section V and VI) and have a "flexible overtime" policy. (Periodic scheduled

maintenance tasks could also be included if AURA were modified to keep a record of total mission miles, rounds, or time, and to conduct those tasks as required. At present those tasks are handled by requiring them to be accomplished with a probability that is a function of the number of days "on the line.")

Resource requirements (maintenance personnel, support equipment, and parts) and time are entered following the cognizant shop number and the number of the part, if any, that is associated with the task. If the shop facility itself is required for the task, or if the task must be accomplished at a rear unit, those constraints are specified by the entry in column 10 (see note to Fig. 3).

If the unit is structured in a company organization, and MOSs of the type required are assigned at company level, the numerical designation of personnel assigned to the first company shall be specified for the task. Support equipment specifications are handled in a comparable manner. All resource data are "packed." If only one set of MOSs or one piece of support equipment is required, it should be entered in the left position. If one of the two sets of personnel is a "load team" (see Card Type #15/1) it must be placed in the left position. As will be noted, the number of the first of any alternative procedures should be entered in columns 40-43.

Task networks are specified by the entries in the columns provided for subsequent and parallel task numbers, and for the rejoin flags. All segments of a task network are to be associated with the same shop, even though maintenance personnel and support equipment must be borrowed from another shop for some of the task segments. Task networks will be "chained" if the last entry of a network limb is the root segment for another network. Care must be taken that no two networks can both point to each other.

In a task network, any segment that specifies a part may be followed immediately by a task that can be made to be contingent on whether a part is required; if a part is not required, the task so designated will be skipped and subsequent tasks will be considered immediately. This option is activated by placing a -1 in the part column of a single task, or of members of a set of parallel tasks. (See illustration in Section V of Volume I.)

The task probability entered with Card Type #7 determines usage for the root segment of tasks entered with the shop collections. The task probabilities entered in columns 36-39 with Card Type #5 only apply to the segments of a task network that follow the root segment and to most tasks that are handled individually (the only exceptions are the tasks for loading basic munitions, which are controlled by the probabilities that such munitions are retained from the previous missions, which are entered with the mission data on Card Type #16).

When a network splits into two or more parallel paths, some of the several paths may be mutually exclusive, others not mutually exclusive; the sign of the task probability for the task segments that begin each parallel path defines how that path is to be treated. All paths for which the task probability is negative are treated as mutually exclusive; tasks with positive probabilities are not mutually exclusive.

If any parallel paths later rejoin, the number of the task segment that immediately follows that junction shall be entered in the "rejoin flag" column of the initial task in each parallel path that rejoins. It is also mandatory that any parallel paths that split and rejoin must all split and rejoin at the same junctions. Furthermore, once begun, any parallel paths that can later rejoin must rejoin; that is the likelihood that activity continues along the path until the junction is reached must be unity.

"The network mean time" normally is estimated internally, and need only be entered for task networks that are not included in the shop collections; for such networks it should be the mean time through the entire task network. The "incompatibility pointer" defines the position in the LISTIN array (Card Type #19) that contains the first item incompatible with the current simple task or tasks.

The criticality of each task for any of five missions is specified with a two-digit integer whose binary equivalent defines task essentiality (1) or deferrability (0); if the task may be deferred only until the end of day, the criticality indices (defined in Table 1) should be increased by 33; if the task may be deferred only for LTHDEF missions, the criticality indices should be increased by 66. This datum need only be entered for simple tasks and for the root segment of a

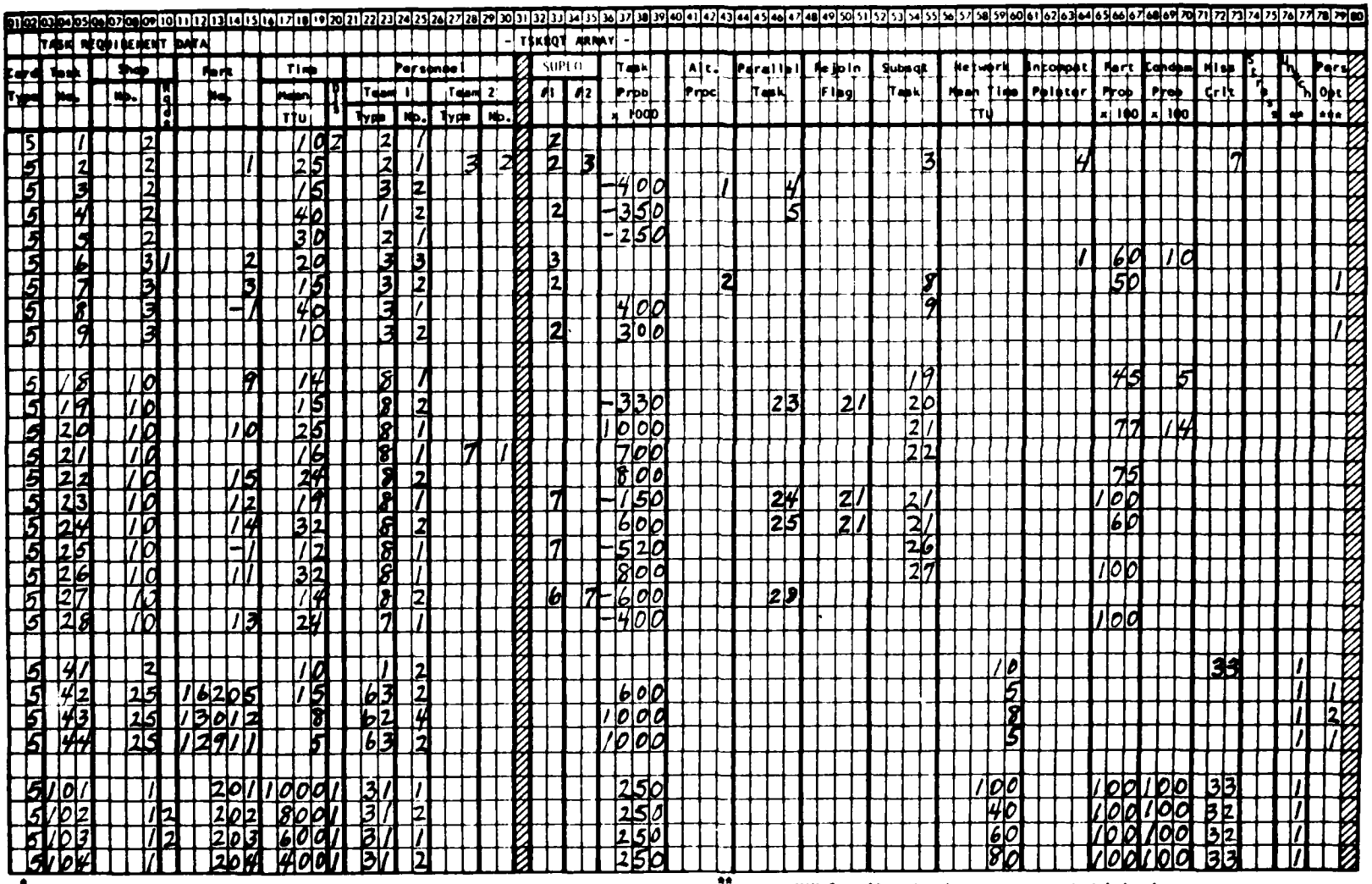
network; if no value is entered, the default value is 32. Space has also been provided so that each unscheduled maintenance task may be categorized by what will be called the "task stress"; this provision is intended to facilitate future code extensions that could, for example, let task efficiency vary with task stress under specified conditions.

All tasks that are not to be categorized as unscheduled maintenance are identified by entering a 1 in column 77. An entry in column 79 designates whether cross-trained or task-assist-qualified personnel are able to handle this task. When records are maintained on disk, an alphanumeric description of the task may be entered in columns 81-100.

Sample Data: The first task listed in Fig. 3, Task #1, is assigned to Shop #2 and is carried out by one Type #2 Maintenance Personnel, using a piece of Type #2 Equipment. The mean task time is 30 minutes (i.e., 10 TTU) with the variance specified by Distribution Type #2. No part is associated with this task. If the resources for this task are unavailable, no alternative procedure is available. The task must be accomplished before any mission can be accomplished (default criticality).

The #2 Task, carried out by two Type #1 and three Type #2 Personnel, using both Type #2 and #3 Equipment, is the root segment of a simple network; this initial task requires 1 hour and 15 minutes (25 TTU). The task is only critical when the second or third mission type is to be done (criticality is 7; see Table 4). If any of the incompatible tasks (beginning in the 61st field of the INCOMP array) are in process, the task may not be started. Three mutually exclusive Tasks, #3, #4, and #5 (denoted by the minus probabilities), follow Task #2: Task #3 is required 40 percent of the time; #4, 35 percent, and #5, 25 percent. An alternative procedure (Task #1) can be used for Task #3, but for no other.

Task #6 requires three Type #3 Personnel an average of 1 hour (20 TTU) using a Type #3 Equipment; furthermore, if the vehicle is at a forward location, it is necessary that it be moved to a rear maintenance unit to carry out this task (specified by the "1" in column 10). Sixty percent of the occasions when this task arises, a Type #2 Part is required; in 10 percent of the cases that a part is removed, it must be condemned. If any of the tasks or shops listed in the incompatible task



*Maintenance requirement
- = 1 Shop not required; rearward maintenance req'd for mobile units
- = 2 Shop not required; rearward maintenance req'd for all units
- = 3 Shop required
- = 4 Shop required; rearward maintenance req'd for mobile units
- = 5 Shop required; rearward maintenance req'd for all units

**Enter a "1" for all tasks that are not unscheduled maintenance

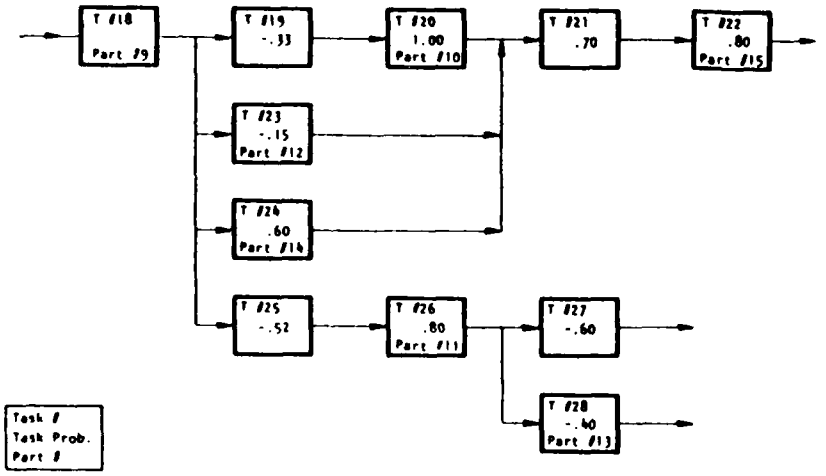
***Personnel Substitutability: 1 if cross-trained personnel may be used;
2 for task-assist-qualified personnel;
3 if either may be used.

Fig. 3 — Vehicle maintenance task requirements

list (beginning in the 67th field) are in process, this task must wait.

Task #7 is the root segment for a simple task network that is assigned to Shop #3; Task #7 takes two Type #3 Personnel 45 minutes to complete. Part #3 is required for Task #7 on 50 percent of the occasions. If a part is required, there is a 40 percent chance that Task #8 is required; if a part was not required, or if it was and Task #8 also was required, then there is a 30 percent chance that Task #9 must be performed to complete the task. If two Type #3 Personnel are not available for Task #7 or Task #9, personnel that have been cross-trained to replace these MOSs could be used; at least one Type #3 Person is required when Task #8 must be handled, however, since no personnel substitutability is indicated for this element of the network.

Task #18 is the root segment for the complex task network sketched below; this network involves 11 task segments and seven parts:

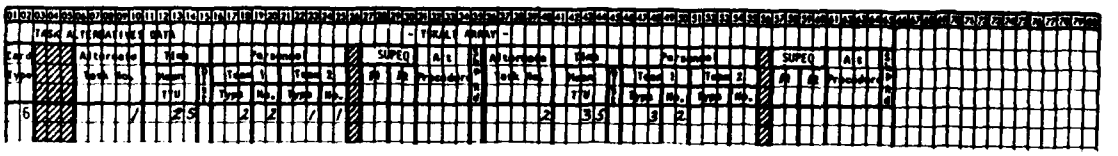


Following completion of the root segment task, one of the three mutually exclusive Tasks #19, #23, or #25 (denoted by the minus probabilities) is selected, and there is a 60 percent chance that Task #24 also must be done. If Task #24 and either #19 or #23 are required, both paths must be completed before a check is made to see if Task #21 is required. Also, if Part #9 had not been required with Task #18, and Task #25 was selected from the mutually exclusive set, that task is bypassed (as dictated by the -1 in the parts column for Task #25) and a check is made to see if Task #26 is required.

Other tasks shown include the refueling Task #41 (see Card Type #15), and the scheduled maintenance tasks for mounting auxiliary fuel tanks (#42) and for loading the basic munitions (#43 and #44). The coded part numbers for the last three of these tasks specify two Type #5 Accessories, two #12 and one #11 Munition (3200 × Class + 100 × Number + Type). The fuel tanks are required for 60 percent of the missions; the expenditure rate for the basic munitions is controlled by mission with Card Type #16. Task-assist-qualified personnel may be used for the fuel tank and Type #11 Munitions tasks; either cross-trained or task-assist-qualified personnel may help with the Type #12 Munition task.

The last four tasks comprise the set of the battle-damage repair tasks as specified on Card Type #15/2; each has a 25 percent chance of needing attention when a vehicle is damaged and all require that the vehicle be towed (criticality = 33). All parts are condemned.

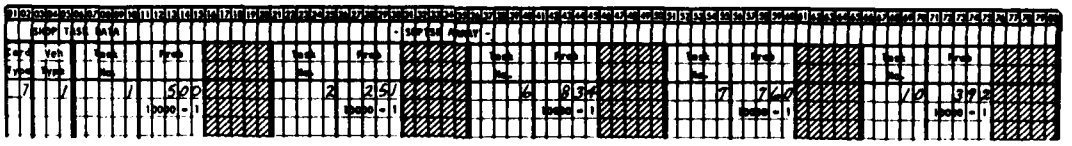
Card Type #6



Alternative procedures and resource requirements for on-vehicle maintenance tasks are specified here. The task numbers for alternative procedures specify the location of the data in the TSKALT array and are distinct from the numbers that define the nominal procedures and resources. As noted, additional alternative procedures may also be specified.

Sample Data: Two alternative sets of resource requirements are shown; the first provides an alternative procedure for Task #3; two Type #2 and one Type #1 Specialist can do the job instead of two Type #3 Personnel, but they require an additional half-hour. Alternative procedure #2 indicates that the same personnel, working without the Type #2 Equipment, could do Task #7 in an extra hour (35 rather than 15 TTU).

Card Type #7



These cards control the incidence per mission of the on-vehicle maintenance tasks associated with the shop task collections. The probability per mission (multiplied by 10,000) is entered for each task number. These data are entered separately from the task data entered with Card Type #5, so that the same tasks may arise on different types of vehicles with different probabilities.

Sample Data: This sample indicates that Tasks #1, #2, #6, #7, and #10 are required after 5.0, 2.51, 8.34, 7.6, and 3.92 percent, respectively, of the missions done by Vehicle Type #1.

Card Type #8

The resource requirements for a parts repair job are structured somewhat like those for an on-vehicle task. The parts removed from a vehicle may be of two types: parts that may be repaired and reused, or LRUs that have a defective SRU that must be diagnosed and replaced. Only one SRU may fail at a time. The repair of a part may involve either a specific procedure or one of two or more different procedures. One procedure is assumed to apply when shop action is required before a part is NRTSed, rather than being NRTSed immediately after removal from the vehicle. If the same shop procedure (maintenance personnel, support equipment, and time) is used, whether the part is repaired at the unit or is determined to require a NRTS action, only one procedure need be listed. The format used with the Type #8 Cards (Fig. 4) depends upon which type of part is being treated. The #8/1 format is used with simple parts, the #8/2 format is used when more than one procedure or SRU is involved, and the #8/3 format is used to specify multiple procedures, SRU replacement procedures, and SRU repair procedures. The part number or LRU number specified in the TSKRQT array (on Card Type #5) denotes where the REPRQT array should be entered for data regarding its repair; therefore, the parts associated with various vehicle types must each be assigned a unique number, except for parts that are common to two or more types of vehicles.

Parts that involve two or more repair procedures but no SRUs are entered with the #8/2 format and are denoted by a minus two in columns 24-25 (59-60). An LRU is denoted by a minus one in the same field. The location of the first repair procedure, or the first of the SRUs in an LRU, is specified in columns 26-30 (61-65). The requirements for the various procedures and the requirements for diagnosing and replacing each of the SRUs in an LRU are entered using the #8/3 format and are also stored in the REPRQT array. The first repair procedure is always used for a part that is checked in the shop before being NRTSed, rather than being NRTSed immediately after removal from the vehicle. If the probability of the first procedure is greater than zero, the same procedure may be selected when the part is to be repaired at the unit; otherwise the first procedure would be used only when the part is checked in the shop and NRTSed.

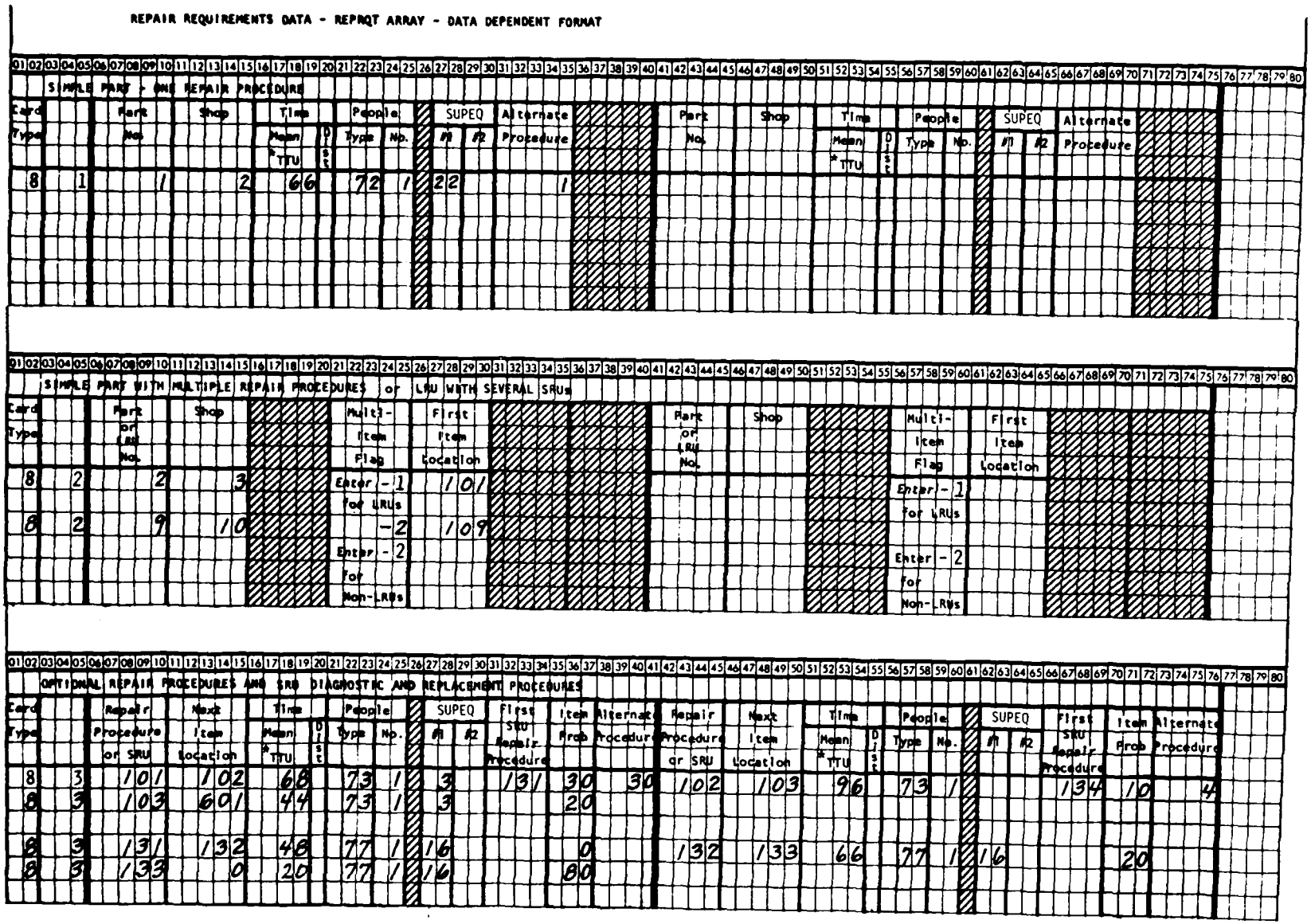


Fig. 4 — Vehicle parts repair requirements

A repair procedure that is numbered lower than NOPART and does not require an SRU *must be* distinguished from one that does by a -1 entry in columns 33-34 (68-69). If the repair procedures that do not involve an SRU are numbered between NOPART and NOREP, the size of arrays that use NOPART as a dimension can be minimized. (Furthermore, the requirement for a negative entry will be avoided, since that entry is made automatically except for those LRUs that have procedures that do not require an SRU, and are numbered lower than NOPART.)

Each alternative procedure, or SRU entry, also specifies (1) the likelihood that that procedure is required or that the SRU is faulty, and (2) the number of the next procedure or SRU, if any. The probabilities associated with the alternative procedures, or with the SRUs in an LRU, must sum to 100.

When an SRU can itself be repaired, the location of the first of the one or more procedures that may be specified for that repair is listed in columns 31-34 (66-69) of the SRU replacement data. If two or more procedures are given for the repair of an SRU, the particular one required in a given instance is selected on the basis of the individual procedure probabilities entered in columns 35-37 (70-72). As with any LRU, the first of the SRU procedures specifies the resources required when the SRU must be checked when it is NRTSed, rather than NRTSed immediately after removal from the LRU. If the probability of the first procedure is not zero it may also be selected when the SRU is repaired at the unit.

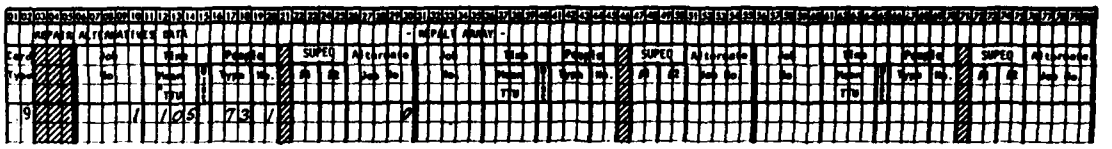
Sample Data: Repair procedures are illustrated for a simple part (#1), an LRU (#2), a simple part with several possible repair procedures (#9), and for an SRU (#101). Part #1 requires one Type #72 Specialist for 3 hours and 18 minutes to repair or to check for a NRTS action, using a piece of Type #22 Equipment. An alternative procedure is listed.

The LRU #2 has three SRUs (#101, #102, and #103) that fail 30, 10, and 20 percent of the time, respectively; in the other 40 percent of the repairs no SRU is required and repair procedure #601 is used. As will

be noted, the times and resources for each of the repair procedures differ, and in one instance, #102, an alternative procedure is listed. Also SRU #101 may itself be repaired.

The #101 SRU is repaired by one of two procedures--#132 or #133; procedure #131 is only used when the SRU is checked and NRTSed (a blank or zero in cols 35-37). The maintenance personnel and support equipment are the same for all these procedures, but the work can require as little as one hour (#133) or as much as 3.3 hours (#132).

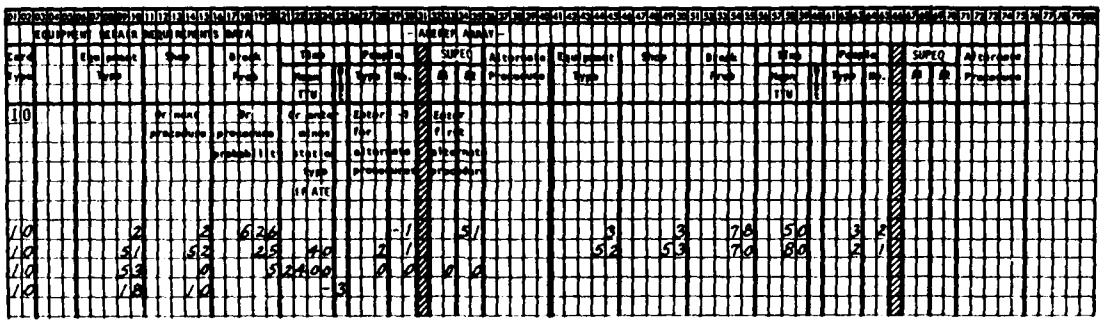
Card Type #9



Data entries for alternative parts repair procedures are structured analogously to those for alternative on-vehicle tasks and are stored in the REPALT array.

Sample Data: This sample indicates that one Type #73 Person can repair Part #1 in 5-1/4 hours without any support equipment; see comments on Card Type #8.

Card Type #10



For repair purposes, support equipment is divided into two categories; those that are either serviceable or must be repaired, and those that also have an intermediate, partially mission-capable state. The former are treated with the procedures that are outlined with Card Type #10 and are stored in the AGEREP array. The latter category, consisting primarily of the ATE used for testing and repairing electronics and electromechanical equipment, are described with Card Types #22/66 and #22/77.

For the first of these categories one or more procedures may be specified for repairing each of these types of support equipment; when more than one procedure is listed, they are assumed to be mutually exclusive and the one that is required for any particular repair is selected by a random process. The data appropriate for each type of support equipment are found in that column of the AGEREP array that corresponds to the number that designates that type of equipment.

The shop to which each support equipment repair is assigned and the likelihood that the equipment is broken following each use are entered in columns 11-15 and 16-20; when a single procedure is always appropriate, the time, maintenance personnel, and other support equipment needed to repair the unserviceable one are entered next. If the repair requirements vary depending upon circumstances, a "-1" is entered in columns 29-30 of the basic entry, and the entry in column 31-35 specifies the location in the AGEREP array of the first of the multiple repair procedures. For those procedures columns 16-20 contain

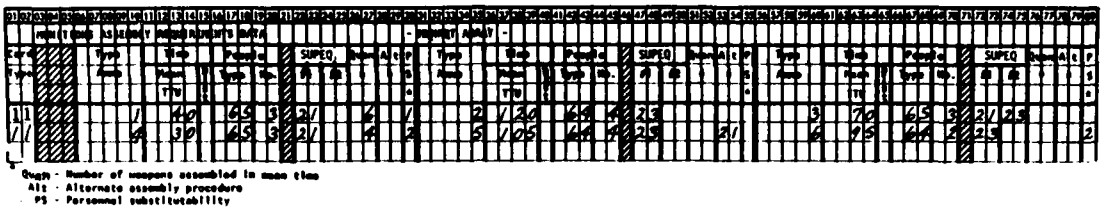
the probability that each of the multiple procedures will be required, and columns 11-15 specify the location of the next procedure.

In all cases an alternative set of resources may be specified for accomplishing the nominal repair.

Sample Data: Repair requirements are shown for two types of support equipment, #2 and #3. Their repair is assigned to Shops #2 and #3. The likelihood that a piece of Type #2 Equipment is found faulty following each use is 6.26 percent; for the Type #3 Equipment, it is 0.78 percent. Two Type #3 Personnel always repair the #3 Equipment, and the nominal task time is 2.5 hours. One of three different procedures may be required to repair a Type #2 Equipment; 25 percent of the time one Type #2 Personnel can repair it in two hours; 70 percent of the same specialist takes four hours, and five percent of the time five days (2400 TTU) must elapse before the repair is accomplished (this type of procedure, one that consumes time but no maintenance personnel or support equipment, can be used to approximate the effect of waiting for a critical piece-part from another location).

The last entry illustrates how the ATE equivalent of an equipment type is identified. In this instance, a #3 Type ATE station is identified as a piece of Type #18 Equipment; the minus sign denotes the special nature of this entry.

Card Type #11

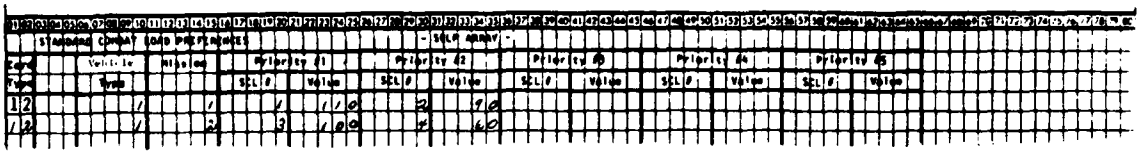


Quan - Number of weapons assembled in mean time
Alt - Alternate assembly procedure
PS - Personnel substitutability

Resource requirements for assembling munitions are specified and stored in the MUNRQT array; the number of the munitions type determines the column in that array in which the data are filed. The quantity of munitions to be assembled for each task should be selected such that the buildup time is no greater than two to three hours, so that the simulated assembly activities will be responsive to sudden shifts in munitions requirements. The default value for the number of munitions assembled is 12. The requirements for alternative procedures, when specified, are also filed with these cards in the MUNRQT array; these data should not be filed in columns defined by any of the munition types considered.

Sample Data: Assembly requirements are shown for six types of munitions. The assembly of six Type #1 Munitions takes three Type #65 Personnel two hours (40 TTU) using a unit of Type #21 Equipment. If available, cross-trained personnel may replace the Type #65 Personnel in assembling the Type #1 Munitions. For assembling #4 and #6 Munitions, task-assist-qualified personnel may assist, but not replace, the normal personnel. In one instance (the #5 Munitions) an alternative procedure permits assembly without special equipment, but requires an additional 1-3/4 hours (35 TTU).

Card Type #12

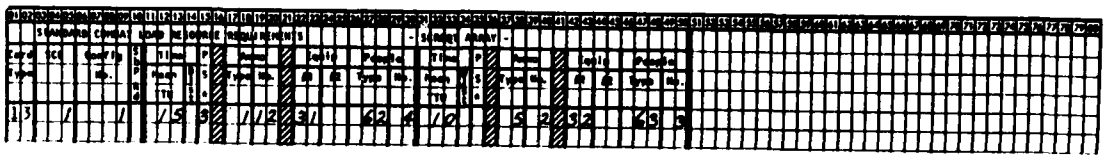


These cards permit the user to specify up to five standard combat loads (SCL) for each combination of vehicle type and mission. The preferred loading is listed first; the least acceptable load is listed last. An effectiveness proxy may be entered for each SCL; these values are summed during the simulation for each mission that is initiated and does not abort, and provide an overall measure of effectiveness. The user must be careful to ensure consistency between the effectiveness proxies for the different types of vehicles and missions.

When the program is executed, resources are sought first for the preferred munitions, and then for the secondary (less effective) options. Resource requirements for the various SCLs are listed in the SCLRQT array.

Sample Data: Combat loading preferences are shown for two missions for Vehicle Type #1; primary and secondary choices have been defined in both cases. The first card image indicates that when a Vehicle Type #1 is sent on a Type #1 Mission, loaded with SCL #1, 110 effectiveness units are tallied; if the required munitions or accessories are not available, mission effectiveness would drop to 90 when SCL #2 is used.

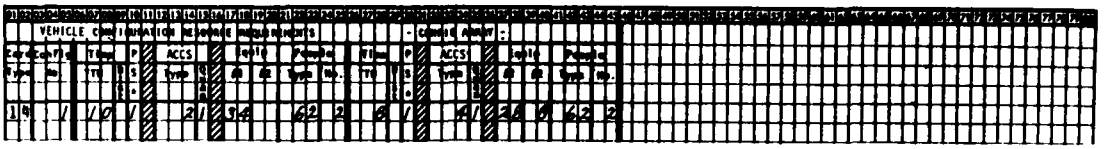
Card Type #13



The munitions loading requirements for the various SCLs are entered here. Since the SCL number denotes the column in the SCLRQT array in which the data are stored, distinct SCLs are required for each vehicle type, unless the time requirements are the same. Configuration type represents a specific combination of SCL and vehicle accessories. Resources needed to set up the vehicle configuration specified in columns 6-9 are handled with the next card type. Either one or two sets of munitions may be specified. If the personnel (crewmen or other munitions MOSs) and support equipment requirements for the two tasks are the same, the tasks may be done in series if there are insufficient resources available for both. Otherwise, both must wait until all resources are available, unless a subordinate SCL may be loaded.

Sample Data: These data specify that SCL #1 involves Configuration #1 and that 12 Type #1 and two Type #5 munitions are to be loaded. Four Type #62 Personnel require a #31 Equipment for 45 minutes to load the #1 Munitions, and three Type #63 Personnel take 30 minutes with a #32 Equipment to load the #5 Munitions. Cross-trained or task-assist-qualified personnel may be used for the first task (the 3 in column 15), but no substitutions are permitted for the second.

Card Type #14



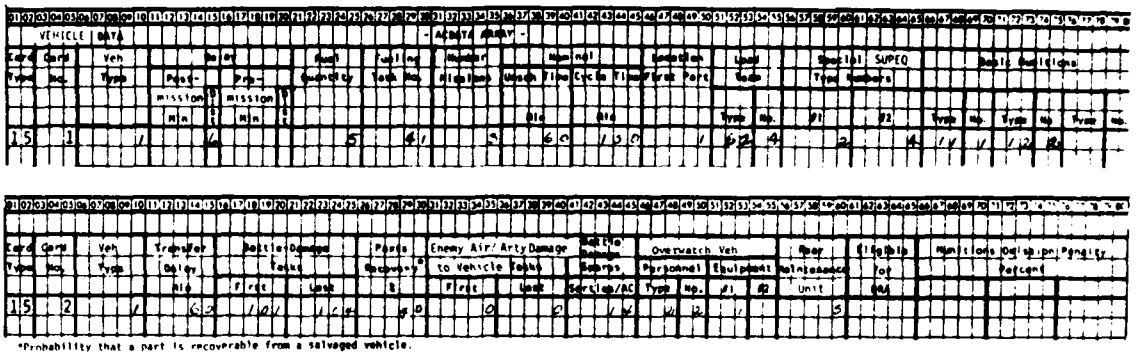
The resource requirements and task times for all vehicle configurations are entered using Card Type #14. Either one or two tasks may be specified. The configuration number denotes the position of the data in the CONFIG array. Accessories are considered to be returned when the vehicle returns from a mission and are returned to stock if inappropriate for the next mission. When the accessories that are to be represented *are consumed*--i.e., dropped or damaged in combat--they cannot be handled here, but *must be treated as a special task assigned to Shop #25* (see the Card Type #5 discussion for these special tasks).

When a vehicle must be reconfigured to meet the requirements of a different mission (or because the required ammunition stocks are depleted), the time required to remove the accessory is assumed to be equal to the time specified here for equipping the vehicle. If either of the sets of accessories is common to the two configurations, only the dissimilar accessories are "changed" during a reconfiguration. Also, as with such descriptors in the other kinds of tasks, the maintenance personnel, support equipment, and time requirements may be satisfied with a null entry; if, for example, the same crew using the same equipment loads two sets of accessories in sequence, the descriptors for the second reconfiguration task could be limited to the accessory, with null entries for personnel, support equipment, and time; the total time would be listed for the first task.

Sample Data: Two tasks are required for Configuration #1. In the first case two Type #62 Personnel are to mount one Type #2 Accessory and will require 30 minutes using a piece of #34 Equipment. The second task

mounts one Type #4 Accessory in 24 minutes; again two #62 Personnel are required. Cross-trained personnel may be used for either task, as designated by the 1 in columns 10 and 30.

Card Type #15



Miscellaneous vehicle data are entered using Card Types #15/1, #15/2, and #16. The first entries on #15/1 permit the user to specify two delays in which no specific tasks are accomplished; one immediately after the vehicle arrives in a bivouac area and one before the pre-mission maintenance tasks are begun. The values specified might be chosen to reflect parking, debriefing time, inspections, or various scheduling inefficiencies. The quantity of fuel (in tens of gallons) and the appropriate task number are specified next. The approximate expected values that are entered for unscheduled maintenance time and for total mission time are only used for projecting the future supply of ready vehicles, and only for vehicles that have not yet returned; the user should derive these values from the various data entered with Card Types #5, #7, and #29.

If the specifications for a munitions load team are entered, only one load team will be permitted to work on any given vehicle at a time; that constraint will be observed even when substitute or alternative personnel are employed to make up the required load team. In AURA, the load team is usually the vehicle's crew. For support equipment types entered into the special equipment fields, it is assumed that only one piece of such equipment need be present at a vehicle to satisfy all concurrent task demands. When a vehicle is always to be loaded with some minimal kinds of munitions, those types should be entered in the last fields on Card Type #15/1 and not included in the mission-dependent munitions requirements. These munitions are referred to as basic

munitions. These entries and the retention data on Card Type #16 are used in assessing the demands for munitions assembly; the resource requirements for loading these basic munitions must be entered with Type #5 Cards (e.g., see Tasks #43 and #44).

The first entry on Card Type #15/2 is an administrative delay that will be imposed when a vehicle is newly arrived at the unit. When vehicle battle-damage repair tasks are specified, the root segments of those tasks should be arranged in a numerically ordered set; the first and last task numbers of that set are entered next on this card. The next entry is the probability that each part will be recoverable from vehicles that are too badly damaged for repair and must be salvaged. A separate set of tasks may be specified for the vehicle damage inflicted by enemy air/artillery attacks on the bivouac area; the root segments of these tasks should also form a numerically ordered set. If a number of missions is entered in the battle damage spares column, quantities of the spare parts that would be required for battle damage repairs are automatically stocked at each unit. The numbers of parts stocked are the numbers that would be expected to be required if a number of vehicles were each operated the specified number of missions; the number of vehicles is either the number of each type initially at each unit or, if OUTFIT is not zero, the number specified on the #23/70 Type Cards.

The next two entries on Card Type #15/2 are used to specify any personnel or equipment that must be maintained with each vehicle that is to be placed around the bivouac area on overwatch duty. The next entry specifies the unit number of that rear unit where vehicles of the specified type are taken for DS/GS maintenance. Initializing the next entry declares that this vehicle may be designated for assignment to "special duty" and will be given priority when vehicle shelters allocated to this role are assigned (see Card Type #19/1). When a "1" is entered in this field, a vehicle requirement for the highest numbered mission that this vehicle type may be assigned to (col. 35 on Card Type #15/1) is interpreted as "special" duty.

The last three entries on the #15/2 Type Card provide the user with options for starting a mission despite the unavailability of certain basic munitions. If any of these three fields is not zero (or null), the vehicle will be permitted on a combat mission without the

corresponding munitions on Card Type #15/1, and the entry is interpreted as the percentage degradation to be applied to the overall mission effectiveness recorded in the effectiveness proxy when the vehicle is sent.

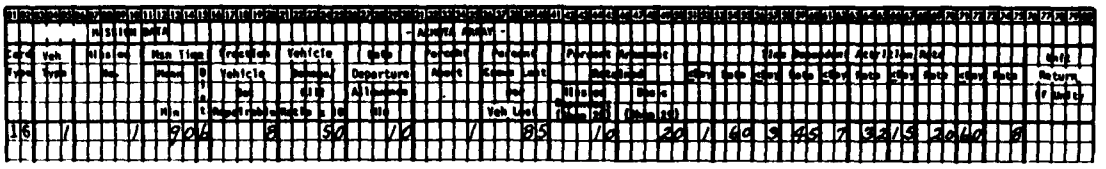
Sample Data: For Vehicle Type #1, there is a six-minute postmission delay. Fueling requires five units (50 gallons) of POL; the time and personnel required are specified with Task #41. The vehicle can be assigned to three different missions. Approximate time for unscheduled maintenance and for a complete mission are 60 and 150 minutes. A munitions load crew consists of four Type #62 Specialists; one piece of Type #2 or Type #4 Support Equipment will satisfy all concurrent demands for either of those types of equipment. The basic munitions that are to be loaded for all missions consist of one Type #11 Munitions and two Type #12 Munitions.

When a Type #1 Vehicle returns to a different unit or is transferred to a different unit, an hour is required for various administrative procedures. For vehicles that receive battle damage in combat, tasks are selected from Tasks #101 through #104, inclusive. For vehicles too damaged to be repaired, 40 percent of the parts are salvaged; those recovered are selected at random from the vehicle parts list.

No repair tasks are specified for vehicles damaged by enemy air/artillery rear area attack. Spare parts are stocked at each unit for repairing battle damage sustained in mission operations, on the assumption each vehicle will run an average of 14 combat missions.

If a vehicle is to be placed on alert, two Type #2 Personnel and a Type #1 Equipment must be assigned. When it is necessary for Type #1 Vehicles to have maintenance done in the rear, the vehicles are to be moved to Unit #5.

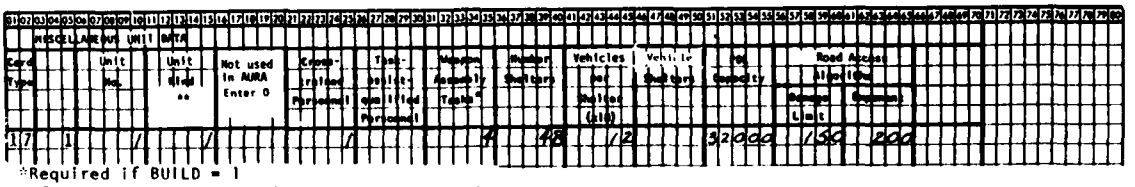
Card Type #16



The only mission data used in AURA are entered here. For each vehicle type, and each of the missions that that vehicle can run, estimates are entered for the duration of the mission, the expected attrition and battle damage, abort rate, and munitions expenditures; different attrition levels may be specified for each of five blocks of time. If vehicles of this type and mission are permitted to "jump off" late, that allowance is also entered. If the members of a mission are to return together, rather than independently, a "1" is entered in the final field.

Sample Data: This card image indicates that the nominal mission time for Mission Type #1 with Vehicle Type #1 is 1-1/2 hours, and that departure up to 10 minutes after the scheduled mission time is acceptable. One percent of the vehicles abort, 10 percent, on the average, return with their mission dependent munitions, and 20 percent retain their basic munitions. For the first day, 6 percent of the vehicles are lost for each combat mission; 4.5 percent are lost on the second through third days, 3.2 percent on the fourth through seventh day, 2 percent from the eighth to the 15th day, and 0.8 percent thereafter. Five times as many vehicles are damaged as are lost, and 8 percent of the damaged vehicles can be salvaged. As noted on Card Type #15/2, 40 percent of the parts, selected at random, are recovered. When a vehicle is lost in combat the crewmen survive only 15 percent of the time.

Card Type #17/1



*Required if BUILD = 1
**If unit is fixed, enter 1; if mobile, enter 2

Miscellaneous unit data are entered with Card Types #17/1 and #17/2. The kind of unit is entered in the first field following the unit number; 1 denotes a unit at a fixed location, and 2 a mobile unit. A null should generally be entered in the next field. A "1" entered here extends the mean on-vehicle task times by NOPOMO time units.

If the maintenance personnel at the unit have been cross-trained for certain tasks, or have been qualified to assist on various tasks, a "1" should be entered as appropriate in the next two fields. The entry in columns 31-35 is used to control the assignment of munition assembly personnel in Shop #30 after all immediate demands have been satisfied; additional assembly tasks are defined and initiated until the total number of ongoing tasks is equal to the value entered.

The number of vehicle shelters (if any) is specified in columns 31-35. The average number of vehicles that may be accommodated in each shelter (times 10) is entered in columns 36-40. The number of these shelters that is to be allocated preferentially to "special" duty vehicles is entered in columns 41-45; damage to these shelters and their contents will be distinguished from that for the other shelters.

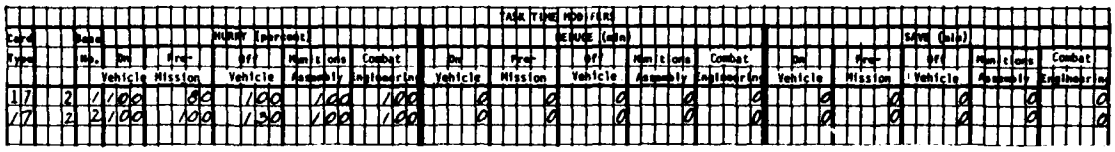
The last entry is the unit's POL storage capacity; that capacity should be expressed in the same units used for specifying POL supplies on Card Type #27 and the vehicle's per-mission consumption--normally tens of gallons. Since this value cannot exceed 32750 it may be necessary to select a different unit of measure--barrels, for example.

The last two entries permit the user to control a special relationship between the "probability that a vehicle is unable to reach the battle area" and the "percentage damage" to one part of the unit's bivouac area (i.e., Facility #35). The "damage limit" identifies that percentage damage beyond which access is impossible, and the exponent

controls the manner in which the probability varies between no damage and the "limit," as discussed in Section IX.

Sample Data: The sample data indicate that Unit #1 is fixed and has cross-trained personnel. At least four munitions assembly tasks are to be ongoing at all times. The unit has 48 shelters, and an average of 1.2 vehicles may be housed in each shelter.

Card Type #17/2



The actual times for various tasks that are drawn from the specified distributions may be modified to reflect various schemes of work speedup. The HURRY, REDUCE, and SAVE arrays control these arrays according to the relationship:

$$\text{Task Time} = \text{HURRY}(i) \times D_j\,[\text{Mean Time} - \text{REDUC}(i)] - \text{SAVE}(i)$$

where D_j represents the value selected from the distribution j, and

i = 1 for on-vehicle tasks
= 2 for premission tasks
= 3 for parts and supply equipment repair jobs
= 4 for munitions assembly jobs
= 5 for combat engineering tasks

HURRY	Percentage of nominal task time
REDUCE	Mean time reduction in minutes
SAVE	Overall task time reduction in minutes

These procedures may be used to modify the many input values on Card Types #5, #6, #8, #9, #10, #11, #13, #14, and #38, by entering values for HURRY, REDUCE, and SAVE with Card Type #17/2. Different values may be specified for each of the five groups of tasks at each unit. If no unit number is entered, the values will be the same at all units. When these values differ from the default values of 100, 0, and 0, task times are computed as shown above.

Sample Data: Card Type #17/2 indicates that premission tasks are to be accomplished in 80 percent of the nominal times at Unit #1, and equipment repairs are to consume 30 percent more than the normal time at Unit #2.

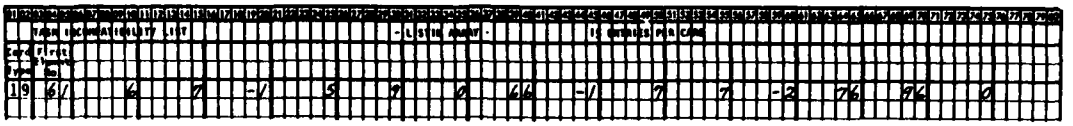
Card Type #18

These cards are used to specify the beginning of the "day" shift for each of the 30 shops and the fraction of the tasks for each of the shops that require a sheltered vehicle to be exposed to a higher likelihood of damage. The permissible entries for shift changes are limited to even-valued hours between zero (midnight) and 10 (1000 hours); the two 12-hour shifts are presumed to be the same for the same-numbered shops at all units. When an operating unit is attacked, each sheltered vehicle is checked as to which shops are engaged in tasks on the vehicle; exposure to the higher damage level is determined on a random basis.

Tasks associated with Shop #25, or the ready-line shop, and with the premission shops (Shops #27, #28, and #29), are treated differently at the time of their shift change. These shops have a flexible overtime policy such that no ongoing tasks are interrupted as a result of the shift change, but are completed before the personnel, usually crewmen, are released.

Sample Data: The day shift commences at 0400 for Shops #27 and #28 and at 0600 for Shops #25 and #29; all others change shift at 0800. Vehicles must be left partially exposed in their shelters a percentage of the time that Shops #1, #4, #7, and #29 work on the vehicles; this occurs 30 percent of the time for Shop #1, 20 percent for Shops #4 and #7, and 60 percent for Shop #29.

Card Type #19



All incompatible on-vehicle task data are stored in the one-dimensional LISTIN array. For each task that may not be initiated while other tasks are under way or until specific tasks have been completed, the entry on Card Type #5 (i.e., TSKRQT (-,11)) specifies the first position in the LISTIN array for the relevant incompatibility data. Whenever an attempt is made to initiate a task, all tasks being conducted on that vehicle are checked to see if they are incompatible. To ease the specification of incompatibilities, entire groups of shops and tasks and task segments may be specified as well as individual tasks.

The task numbers of the individual tasks that are incompatible are entered first and the TASKQ is searched to see if any of those tasks are in progress. If the task can not be processed when other shops are working on the vehicle, the number "-1" is entered, followed by the first and last shop number; one or more shop number pairs may be listed in sequence. If the task is incompatible with an entire block of task numbers, the number "-2" should be entered and followed by the first and last task number in that block (several task number pairs may be entered for several incompatible blocks of tasks). If the task must not be started until after a set or sets of task segments are completed, the number "-3" should be entered and followed by the first and last task segment numbers of each such set (several task segment pairs may be entered). A zero entry in the LISTIN array denotes the end of that particular sublist of incompatibilities.

Sample Data: These data are filed in the 61st thru 75th elements of the linear LISTIN array. Data in columns 6-30 specify those activities that

may not be ongoing when Task #2 is to be initiated; the first two numbers refer to Tasks #6 and #7. The number "-1" signals that the following two numbers are the first and last of the ranges of shops that may not be active; thus Task #2 may not be started if Shop #5, #6, #7, #8, or #9 is performing a task on the vehicle.

Data in columns 36-75 similarly specify that Task #6 may be initiated if Task #66 or any job by Shop #7 is in progress; furthermore it may not be started if any task number in the range #76 to #96, inclusive, is in process.

The first entry of an incompatibility list is specified on a Card Type #5 by naming the appropriate element in the linear LISTIN array; in this case, Task #6 specified element #67, since Task #66 is the 67th element. If some other task was incompatible only with Tasks #76 through #96, the incompatibility pointer should specify #71, reusing a part of the Task #6 list, thereby saving storage space.

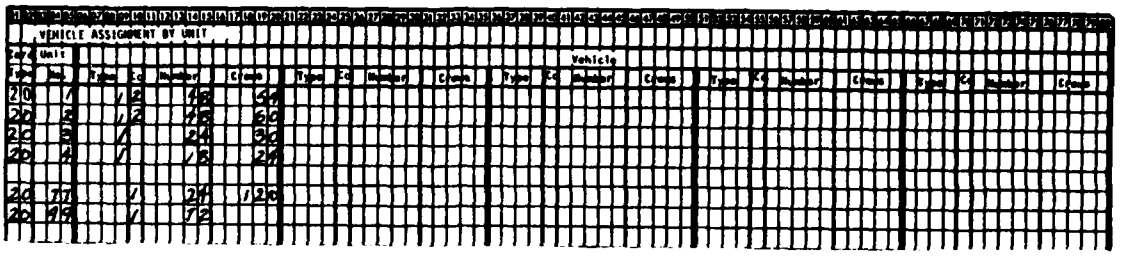
INITIAL STOCKS OF UNIT RESOURCES

The next eight types of cards (#20 thru #27) define resource availability at zero time for each of the combat units. These data are required for each type of each of the eight resource classes that the user has distinguished in his descriptors of task requirements. These data may be entered separately for each unit; or, if no unit is specified (except for vehicles, crewmen, and POL), the same quantity of each class and type of resource is provided at each unit. (When all but one unit or only a few units have the same quantity of a resource, the resource can first be entered for all units with a zero unit number, and then corrected for that unit(s) with a different quantity.)

Other aids are available for Card Types #21, #22, and #23. When an "88" is encountered in the "J" field for any of these card types, two more entries are expected: #U1 and #U2. These entries designate that the entire stockage array for that class of resource is to be copied from Unit #U1 into the storage space for Unit #U2. If this card is placed at an intermediate point in the entries for Unit #U1, only the data entered to that point are copied for Unit #U2. A more sophisticated aid is available for parts data; it automatically generates parts stocks and initializes the parts pipelines.

The quantities of all types of these various resources that are available in depots to replace losses may also be specified with the #20 through #27 Type Cards. When a "99" is entered in the "J" field for any of these card types, the total numbers of resources of types I through I + 9 that are available at time zero are listed in the ten 5-column fields in columns 11-60, where I is the resource type listed in columns 6-10 (see Card Type #23/99).

Card Type #20



Initial vehicle inventories may include up to five different types of vehicles at each operating unit. This card type is used to specify the initial inventory of each type of vehicle and the initial number of crews qualified for that type of vehicle at each unit. The total number of vehicles in the simulation at any time is limited to the size of the ACN array (i.e., MAXACN), and the total number of crews is limited to the size of the PILOT array (i.e., NOCREW).

The Type #41 and Type #42 Cards are used in conjunction with Card Type #20 for initializing vehicle configurations for various missions and for initializing the status of vehicle maintenance; those cards must be entered after the Type #20 Cards.

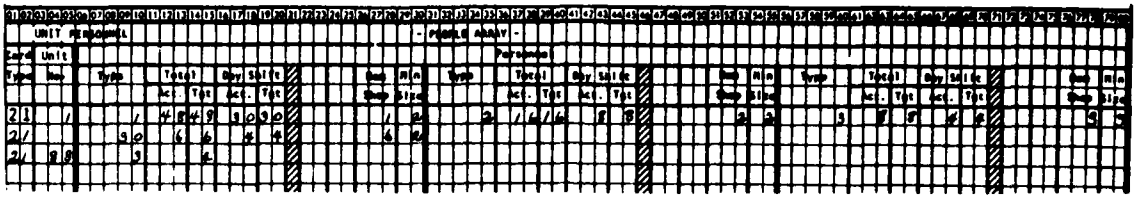
The vehicles of a given type at any particular unit may be separated into two or three companies by entering a "2" or "3" in the "Co" column. When this is done, maintenance personnel and support equipment may be assigned separately to each company, rather than all vehicles drawing upon a common group of such resources. Organization of those resources is controlled by the ALTPEO and ALTAGE arrays that are entered with Card Types #45/1 and #46.

The Type #20/77 Cards are used to initialize the pool of "filler" vehicles, if any, and to specify the time required (usually hours) to move the vehicle to the operating unit when it has been assigned. The Type #20/99 Cards impose constraints on the number of vehicles of each type that are available to replace losses incurred during combat operations or from rear area attacks. The availability and delivery delays for these replacement vehicles are controlled by the Type #43 Cards; these vehicles are in addition to those that may be designated

for the filler force. Each filler vehicle and each replacement vehicle is moved by a crew that is presumed to be reassigned to the operating unit on arrival.

Sample Data: Units #1 and #2 each have 48 Type #1 Vehicle organized into two companies; Unit #1 has 54 crews and Unit #2 has 60. Units #3 and #4 also have Type #1 Vehicles; the assignment is 24 vehicles at Unit #3 and 18 at Unit #4. Twenty-four #1 Type Vehicles are available in the theater as fillers and can reach their assigned unit in two hours. In addition, 72 #1 Type Vehicles are available for replacing vehicles lost in combat, and can reach their assigned unit in 3.5 days (see Card Type #43).

Card Type #21



Unit personnel resource descriptors include the number on the day shift and the total number on hand at zero time; the difference is assumed to be on the night shift. In addition to "actual" values, the user must also enter the "target level" for each of these two factors. The target levels may be the same as the actual levels or the "authorized" (MTO&E) levels, or they may be different from those two; the target level, however, may not exceed 99, whereas the actual values may be as large as 320. The target levels permit dynamic estimates of resource depletion and provide a basis for theater resource management. Whenever the total number of people of a given type in a unit changes, the day/total ratio of the target levels is used to apportion the new force among the two 12-hour shifts, subject to the minimum shift size constraint, when entered.

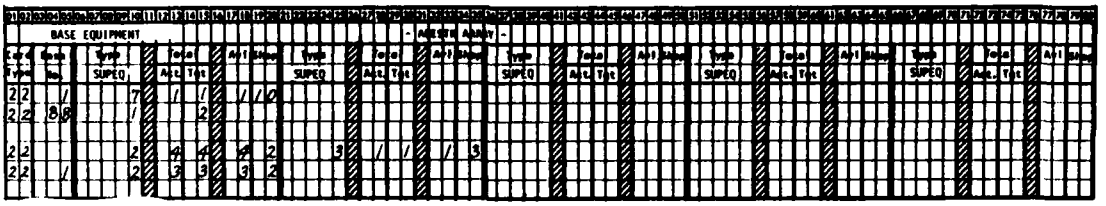
If personnel of a given type are organized into several separate subgroups, the personnel in each group will be identified by different personnel type numbers. When personnel of a particular type are assigned several different designations, it is assumed that the lowest numbered personnel type is associated with the first subgroup, or company, and that the next be with the second, etc.; the highest numbered type is assumed to be assigned to battalion level. Equivalent personnel types are identified as such with the Type #45/1 Cards. When personnel are designated for on-vehicle tasks on the Type #5 Cards, it is mandatory that the lowest type number for the specialty be specified.

Combat engineer personnel are treated in a distinct manner; their designations must be greater than (NOPEOP - CEPEO), and both shifts must have the same number of each type of personnel.

Sample Data: The first card image indicates that Unit #1 has 48 Type #1 Personnel, 16 Type #2 Personnel and eight Type #3 Personnel; of these, 30, 8, and 4 are on the day shift, respectively. The minimum shift size is two for Types #1 and #2, and three for Personnel Type #3.

The second card image assigns six Type #30 Personnel to each of all the units, since no unit number is mentioned. The third card image specifies that Unit #4 should be staffed with the same numbers of personnel as Unit #3. Since no limits on replacement personnel are specified with a Type #21/99 Card, all personnel losses will be replaced if so specified with the Type #43 Cards.

Card Type #22



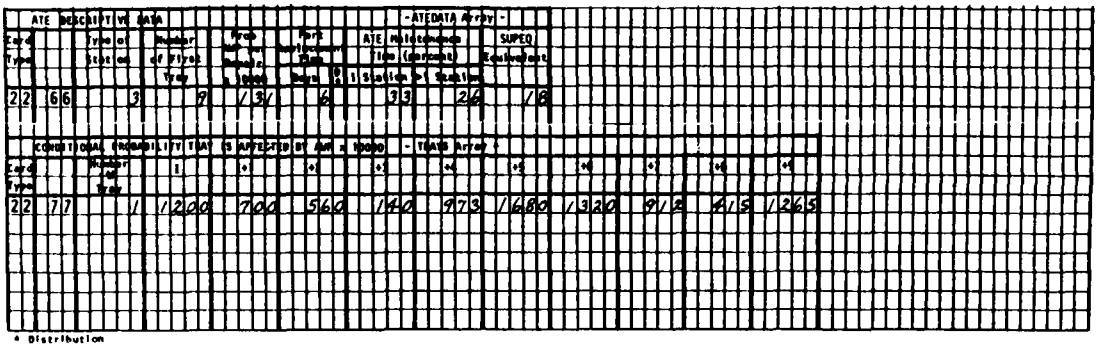
For each type of support equipment to be distinguished in the simulation, initial entries include the total number in the unit, a target level for the total number, and the number that are not in use at zero time. All three numbers would be the same if the unit were fully stocked and all shop tasks were assumed to have been worked off at zero time (except that the target level may not exceed 99).

If support equipment are assigned to different company organizations, they will be numbered differently, as with the personnel data described above, and the stocks for each of the organizations will be identified; the equivalent types will be identified with the Type #46 Cards.

Support equipment employed by combat engineers must have designations greater than (NOAGE - CEAGE).

Sample Data: The first card image equips Unit #1 with one piece of Type #7 equipment and assigns it to Shop #10. The second card equips Unit #2 with the same equipments that have been designated for Unit #1, up to this point. The third card image equips all units with four Type #2 and one Type #3 Equipment. All are available at the beginning of the simulation. The fourth card image changes the initial stocks of Types #2 and #3 to three and two, respectively, at Unit #1.

Card Types #22/66 and #22/77



* Distribution

The specialized support equipment used for testing and repairing electronic and electromechanical equipment--the ATE or Automatic Test Equipment--may also be simulated in AURA. The manner in which the special characteristics of ATE are modeled in AURA is discussed in Section VII. Whenever an LRU repair is completed using an ATE, additional time is allocated for maintenance of the station. This is handled by increasing the LRU repair time by a user-specified percentage. When that time is over a check is made to see if any piece part needed for station maintenance was not in stock. If so, the station's residual capability to repair LRUs is estimated on the basis of statistics that indicate how frequently each particular LRU repair capability is lost, on the average, when an ATE part is back-ordered. To do this we imagine that each station is divided into a number of sections, or "trays," one tray for each type of LRU, and when a part is back-ordered the mission capability of each tray is determined on the basis of the statistical experience.

To organize the necessary input data, the user must number each type of station and each "tray" associated with each station. The station type numbers should be in sequence beginning with Type #1 and the trays should be numbered consecutively from the first tray in Station #1 to the last tray in the last type of station. The user then identifies the correspondence between the support equipment type and the station type on Card Type #22/66, and between the part number and the tray number with entries in the AISDTA array (see cols. 11-15 on Card

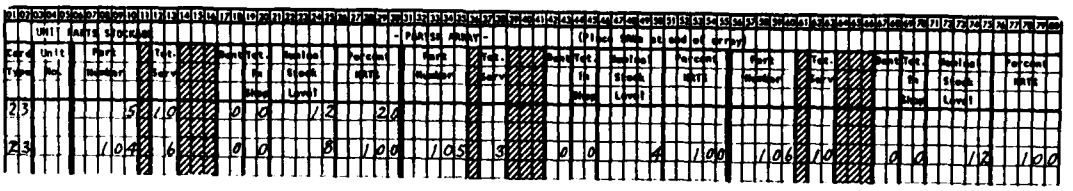
Type #22/66) and in the TRAY array (see Card Type #23/78). The #22/66 and #22/74 Card Types provide the rest of the required data.

The entries for each type of station on Card Type #22/66 include the station-type number, the location in the TRAYS array of the first tray associated with the station, the probability that a part will be unavailable for ATE maintenance following each use of that ATE station, the order and ship time to replace a needed part, the increase (a percentage) in LRU repair time to be used to represent ATE maintenance, and the number of the equivalent support equipment. The probabilities that an individual tray is affected by a missing part are entered with Card Type #22/77.

Sample Data: The #22/66 Type Card provides characteristics for the #3 Type of ATE Station. The first "tray" associated with this station is located in the ninth position in TRAYS array. After 1.31 percent of the times this type of station is used, a piece part required for maintenance of the ATE is unavailable and must be ordered; six days, on the average, are required to obtain the needed component. The actual repair time for each LRU processed on station #3 must be increased by 33 percent, to account for necessary ATE maintenance (if two or more stations of the same type are available for cross-checks, "hot mock-ups," etc., only 26 percent additional time is required). The equipment identification number for the #3 ATE Station is #18.

When a piece part is required to service the ATE and it is not available, the subsequent mission capability of the station is affected as specified by the #22/77 Type Card. In this instance there is a 12.0 percent chance that the LRUs associated with Tray #1 will not be reparable if a piece part is unavailable for ATE maintenance; the likelihood for the other trays varies from 1.40 percent for Tray #4 to 16.80 percent for Tray #6.

Card Type #23



Ten distinct formats are used in connection with Card Type #23 to permit the user to either specify spare part stock levels explicitly, or to direct AURA to generate exemplar stock levels consistent with user-specified parts procurement policies.

Entry of Specific Stock Levels

When the user chooses to enter the stock levels himself, the first of these formats is used; entries include the number of serviceables (i.e., available spares), the number of reparables or "bent" parts,[2] and the "normal" or authorized stock levels. The percentage of reparables that can not be repaired at the unit--the NRTS rate--is also entered. The reparable ("bent") parts include both those awaiting repair and those undergoing repair (if any); all bent parts are presumed to be stored in the appropriate shop and are at risk to destruction if that shop is damaged by attack. When an on-vehicle task is initiated, tests are made to see if a part is broken; if it is, it begins an administrative delay, after which it is repaired in the local shop or, if it is to be NRTSed, it is prepared for shipment. The "nominal stock level" at an operating unit is taken to be the level that is authorized for the vehicles initially assigned to that unit, and it is used with certain of the decision algorithms for reaching judgments during the simulation as to which units have the greatest need for parts. When a unit has been designated as a GSRF, or as the location of the corps or theater manager, the "nominal stock level" at that unit defines the minimum stock level to be maintained at that location; serviceables

[2] This entry normally is zero, with the reparable status at zero time being generated by the ZSHOPS subroutine; see Card Type #42.

above this level are "pushed" to the most needy unit, if that resource management mode has been selected. The number of serviceable parts of any given type may not exceed 320 (except at the PWRMS location), and the nominal stock level may not exceed 250.

Several other Type #23 Card formats are illustrated in Figs. 5 and 6. One is used to supply data on which units may be checked for a part when the simpler of two lateral supply doctrines is used. A Type #23 Card enters these data when a "77" is entered in the "J" field. The calling unit is entered in columns 6-10 and the units that may be called are entered in the next five 5-column fields; these five units are called in order. As indicated on page 63, an "88" or "99" in the "J" field can be used to have the parts at one unit duplicated at another, or to enter the quantities of spare parts available at depots for replacing losses. Card Type #23/78 is used to identify the corresponding tray number (see Card Type #22/77 and Section VII) for those LRUs and SRUs that are repaired with ATE equipment.

Parts Stockage Algorithms

AURA provides special subroutines that permit the user to generate the parts stock levels for any unit; these are activated when OUTFIT is initialized on Card Type #3/3. The parts provisioned are for those unscheduled maintenance tasks included in the shop collections whose occurrence is controlled by Type #7 Card entries. The numbers generated are appropriate for a mobile combat spares kit. They do not, however, make any provision for the additional parts that may be needed for repairing damage sustained in battle or in rear area attacks.

Card Types #23/70 and #23/72 are used with the parts generation option to describe those factors that define stockage policy; they include the unit number and kind, as well as the type and number of vehicles and the nominal mission rates, unit repair cycle times, order-and-ship times in peace and war, and safety factors. Unit kind determines whether the vehicles operate from a fixed location or from a mobile one; KIND is 1 for the former and 2 for the latter. If a GSRF is simulated, it must be assigned its own unit as well as its own NRTS rates and other policy factors, except that no vehicles are to be assigned at that location.

FORM 20
8 FEB 68

FORMS FOR SPECIAL PARTS OPTIONS INCLUDING AUTOMATIC INITIATION OF UNIT STOCKS AND PIPELINE

POLICY DATA — **- POLICY ARRAY -**

Card Type	Unit	Element No. of Ith Item	I NRTS	I BUY	I+1 NRTS	I+1 BUY	I+2 NRTS	I+2 BUY	I+3 NRTS	I+3 BUY	I+4 NRTS	I+4 BUY	I+5 NRTS	I+5 BUY	I+6 NRTS	I+6 BUY	I+7 NRTS	I+7 BUY	I+8 NRTS	I+8 BUY	I+9 NRTS	I+9 BUY
232		without GSRF 11			20		40	1			50											
233		with GSRF 11			80		100		80		100											

PARTS COST DATA ($100s)

Card Type	Number Ith Part	I	I+1	I+2
236	11	300	275	6

UNIT DATA — **- SPARTS ARRAY -**

Card Type	Unit No.	Unit Kind	Type Vehicle	Number Vehicle	Mission Rate (x 100) Peace	Mission Rate (x 100) War	Unit Repair Time Hours Peace	Unit Repair Time Hours War	Order/Ship Time Days Peace	Order/Ship Time Days War	Travel Time Hours	No on-hand SRU Stocks *
230	1	1	1	49	80	120	72	48	10	20		
230	2	1										
230	3	2	1	84	80	120	72	48	10	25		
230	4	2	1	18	80	120	72	48	10	25		

*SRUs not stocked at operating units for GSRF-eligible LRUs if = 1; all LRUs if = 2.

Fig. 5 — Automatic spare parts initialization data

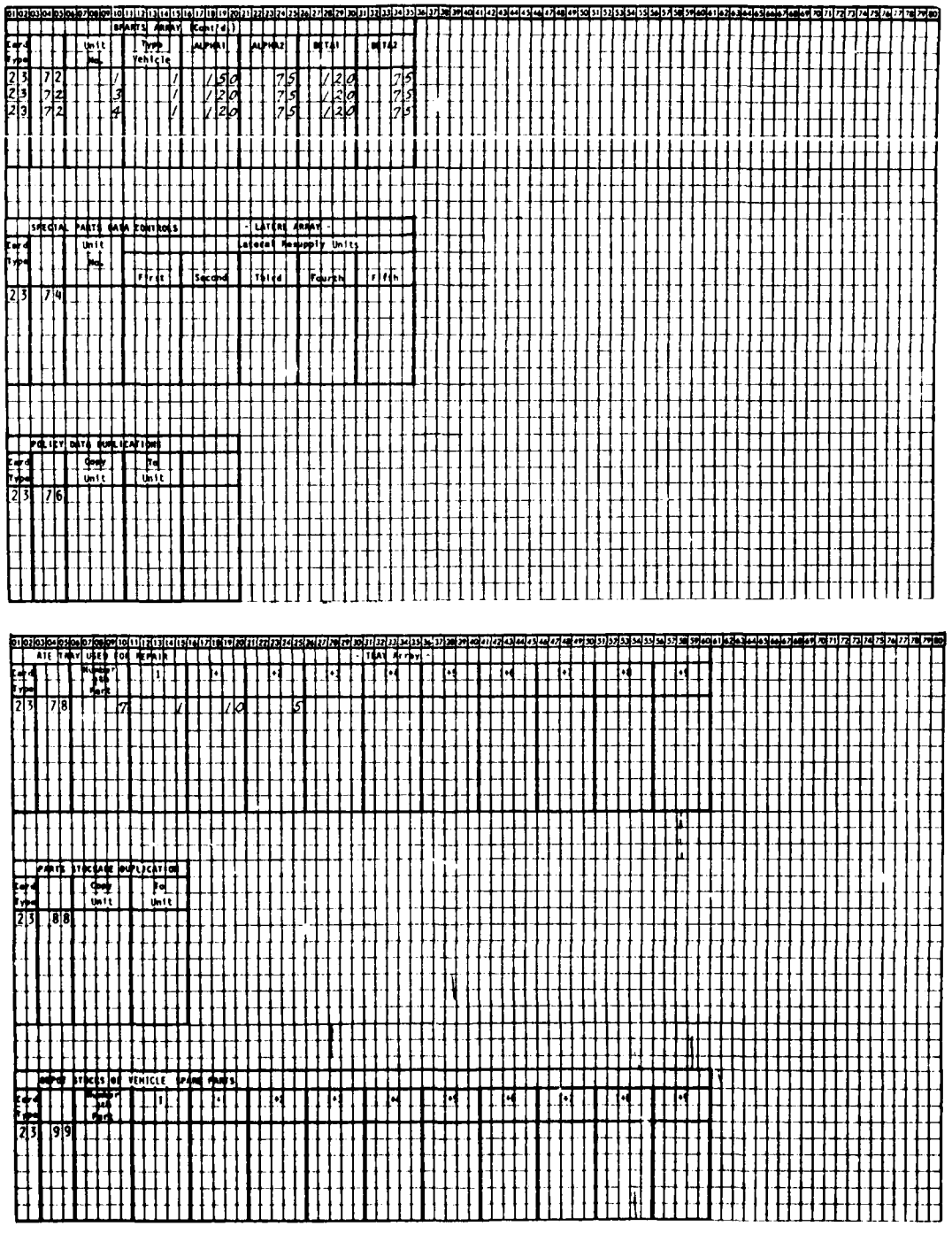


Fig. 6 — Auxiliary vehicle spare parts control options

NRTS data for the parts stockage algorithms are entered using Card Types 23/20x and #23/30x for each part type. The 23/20x Cards define that fraction that would be NRTSed at unit x if there is no GSRF in the theater, and the #23/30x Cards define the same data for the case in which there is a GSRF. If a part, LRU, or SRU is NRTSed 100 percent of the time but first undergoes a normal administrative delay and then a shop check, the NRTS value is entered as 100; if the part is NRTSed immediately upon removal, the NRTS rate should be entered as 101. When NRTS data are not entered for parts, the default value is set to 101, i.e., parts for which a NRTS rate is not entered will not be subjected to an administrative delay nor bench-checked before shipment. The "buy" column on the #23/30x Card is currently not used; on the #23/20x Card a "1" entered in the "buy" column prohibits procurement of that part type for a combat PLL or ASL. The stockage calculations are explained at greater length in Section V.1 in Vol. I. If the POLICY array data entered with Card Types #23/20x and #23/30x are the same at two units, a #23/76 Type Card can be used to duplicate the data for one unit at another. (Because a #23/76 Card duplicates only that data already entered, this card can be used to copy some, but not all, POLICY entries from one unit to another, by appropriate placement of the card among the entries for the first unit.)

When a GSRF is not simulated, the #23/30x Cards may be used to provide the user an option to modify the NRTS rates at a specific time during the simulation. This might be desirable, for example, when general support repair facilities become available in the theater. To use this option, see the instructions for Card Type #31.

Card Type #23/66 provides unit cost data that are used to calculate combat PLL and ASL stock levels with an algorithm developd by Kamins that approximates the "marginal value" calculation (when PMODE=1); these data are also used to compute the total costs for all the parts procured and "authorized" for each unit.

If the control variable FULL that is defined on Card Type #3/3 is zero rather than one, a nominal number of each type of part that is NRTSed to other locations will be entered into the supply pipeline for delivery at random times after the simulation begins. If the user

wishes to specify that the stocks that have been procured are short of the computed allowances, two procedures are provided. The first procedure for shorting stocks reduces the estimated stock level for each type of part by SHORT percent; the second reduces the stock level for a portion of the part types to a value chosen at random between K1LOW and (K1LOW + K2LOW) percent. If TOOFEW is greater than zero, the number of part types chosen at random to be shorted is [TOOFEW/10] percent of the part types; if TOOFEW is "-1", the probability that any part type is shorted is equal to that part's unit cost divided by the unit cost of the most expensive type of part. These procedures may be used separately or together. If RANDM is one, the availability of each part is determined by a random draw; otherwise the shortage is the expected value of the shortage.

Parts for battle damage repair can be specified separately, using the basic Type #23 Cards, or can be provisioned by initializing columns 41-45 on Card Type #15/2. In addition, shortages (overstockage), relative to the numbers computed with these algorithms may be represented by separately specifying negative (positive) numbers of parts with the basic Type #23 Cards. The user is restricted, however, to entering at most 300 specific stock levels for each unit, in addition to those generated by the stockage algorithms; the part types so entered may be the same as or different from those dealt with automatically.

Sample Data: The first card stocks all units with ten serviceable Type #5 parts. There are no reparables at any unit at the beginning of the simulation. Twenty percent of these parts cannot be repaired locally. The target level is 12 parts of that kind. The second card image provides spare SRUs for Part #5, which is an LRU (see Card Types #8).

Card Types #23/20x and #23/30x present the NRTS rates that are used when AURA generates spare parts stocks. These data indicate that in the absence of a GSRF 20 percent of Type #12 Reparables would be NRTSed at Unit x, as well as 40 percent of Type #13 and 50 percent of Type #15. Furthermore, Type #13 Parts would not be procured for a combat PLL or ASL (depending on the unit). The data also indicate that all #13 and

#15 Parts would be NRTSed if there were a GSRF, and 80 percent of Part Types #12 and #14 would be NRTSed. Without a GSRF no #14 Parts would be NRTSed, since the null entry is taken to signify a zero NRTS rate.

The policy options that will be used in automatically generating parts levels are illustrated with the #23/70 and #23/72 Cards. Units #1 and #2 are both to be treated as in-place units (KIND = 1) that operate 48 Type #1 Vehicles. The nominal peacetime and wartime mission rates are assumed to be 0.8 and 1.2 missions per vehicle per day; unit repair times are 72 and 48 hours in peace and war, respectively; and the order and ship times are 10 and 20 days in peace and war. No unit-GSRF travel time is entered since there is no GSRF. The safety factors (Card Type #23/72) that are to be considered in computing stockage levels are 1.5 for LRUs associated with mission-essential tasks, and 0.75 for those that are not. For SRUs the factors in these same circumstances are 1.20 and 0.75.

Combat PLLs or ASLs (again, depending on the unit) are specified for Units #3 and #4, KIND = 2 specifies these units operate in the field in wartime. Since PMODE equals 1 (see Card Type #3/3) the approximate marginal value logic is to be used in computing the stock for these combat PLLs or ASLs. The other policy factors governing parts procurement for these units are the same as for Units #1 and #2, except that fewer vehicles are to be covered, and the safety factor for mission-essential LRUs is only 1.20.

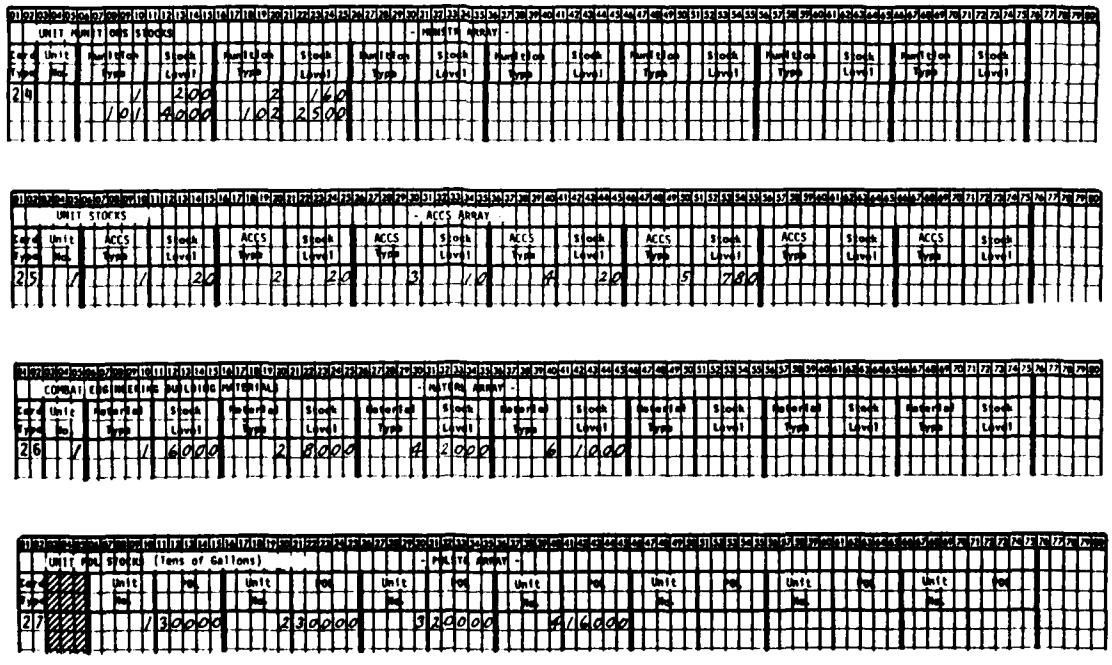
The sample cost data on the Type #23/66 Card indicate that #11, #12, and #13 Type Parts have unit costs of $30,000, $27,500, and $600, respectively.

When parts are required at Unit #1, the #23/74 Type Card indicates that Unit #2 is first asked if it can fill the requirement; if not, Unit #3 is asked. The #23/76 Card indicates that the various NRTS data entered with the #23/201 and #23/301 Cards for Unit #1 also should be applied to Unit #2. The #23/78 Cards specify which tray in the ATE string is associated with a particular LRU or SRU; this sample specifies that Trays #1, #10, and #5 are used with LRUs #1, #2, and #3, respectively.

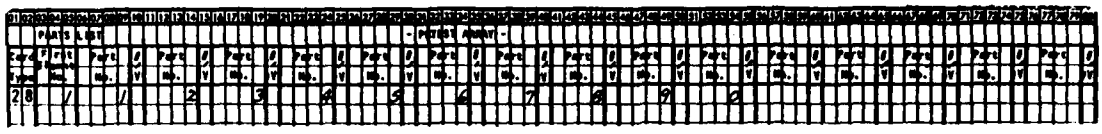
Card Types #24, #25, #26 and #27

These cards specify the initial stocks of munitions, accessories, building materials, and POL. The "J = 99" version of each card type permits the user to indicate the stock levels available for resupply for whichever resources have resupply limitations. Use of the normal munitions type number designates assembled munitions; for unassembled munitions, add 100 to the nominal type number.

Sample Data: The first cards stock all operating units with 200 Type #1 and 160 Type #2 Munitions that are assembled, and 4000 and 2500 of the same types that are unassembled.

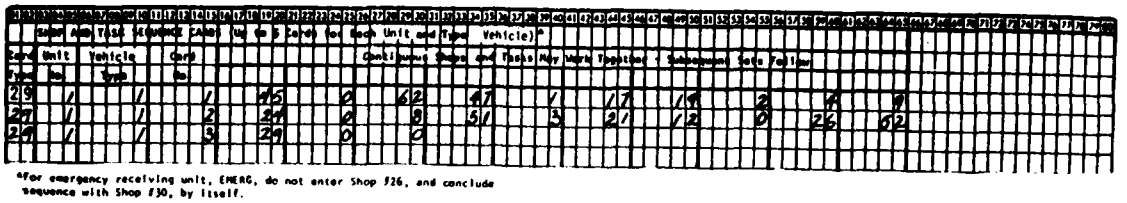


Card Type #28



These cards define the one-dimensional parts-list (PRTLST) array. These data are used when parts are to be salvaged from a vehicle too badly damaged for repair. The numbers of all parts and all LRUs on each vehicle type that are to be considered eligible for salvage are entered, as well as the quantity of each of these items that are used on the vehicle. If the quantity is left blank, it is assumed that the vehicle only uses one part of that type. A zero is used to denote the end of the parts list for each vehicle type. The position in the array of the first part for each vehicle type is specified on Card Type #15. The position within the PRTLST array of the first of the entries on each card is defined by the value in columns 3-5.

Card Type #29



*For emergency receiving unit, EMERG, do not enter Shop #26, and conclude sequence with Shop #30, by itself.

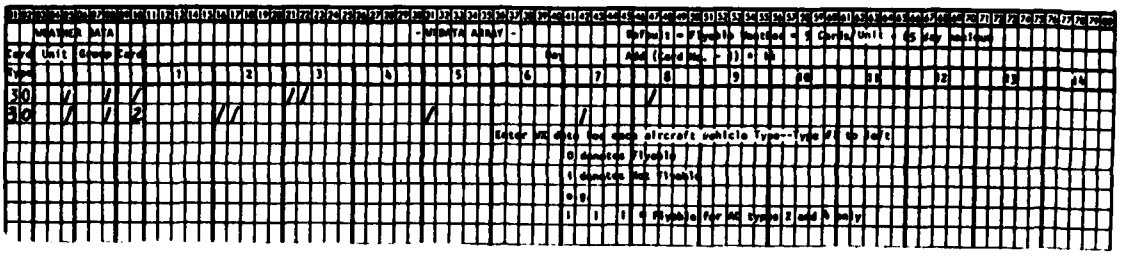
These cards define the order in which on-vehicle maintenance tasks are to be scheduled. Tasks may be entered individually or as collections of work center (shop) activities. When a shop number is entered, all tasks associated with that shop number in the SHPTSK array (Card Type #7) are implied. To be distinguishable, all numbers less than 31 are interpreted as shops and all others as tasks.

The order in which tasks are carried out is controlled by the position of the task and shop numbers on these cards. The numbers may be entered in any order; when two or more tasks or shops may be worked at the same time, the numbers are entered in successive fields; if two groups of tasks or shops may not work on a vehicle simultaneously, and one must follow the other, they will be separated by a null entry in a field. The last item is denoted by two following null entries. Task organization may be further modified and controlled by the LISTIN array of incompatibility data (see Card Type #19).

Up to five cards may be used to enter the task and shop sequence for each unit-vehicle-type combination. A distinct set of cards is required for each combination, unless the unit number is not entered, in which case all units will function in a common manner.

Sample Data: These three cards illustrate how the on-vehicle maintenance task schedule illustrated in Fig. 6 of Vol. I would be entered for the Type #1 Vehicle at Unit #1.

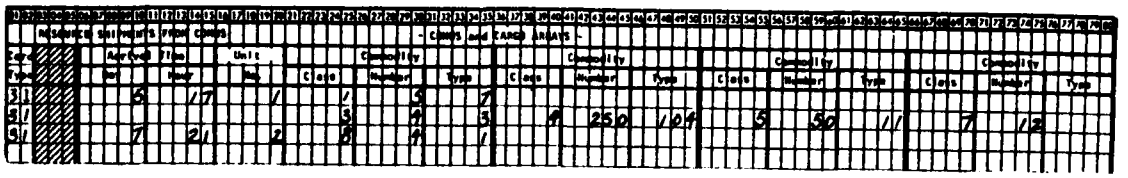
Card Type #30



On-vehicle maintenance tasks that are not mission-essential may be deferred, and may be worked off at night. If there is sufficiently bad weather, a lull in operations, or a stand down is in effect, they may be done during the day as well. The weather or stand down status can be entered by unit and by vehicle type for a 65-day period with these cards. Two groups of five cards with 14 entries each may be submitted for each unit; the first group is used for the first five vehicle types; the second group is used with the last four vehicle types. Each field is filled with ones or zeros (blanks) to indicate the weather or mission holds on the nth day. The left-most column of the first group pertains to the first vehicle type and the right-most column to the fifth type; the left-most column of the second group applies to the sixth type of vehicle and the next to the right-most to the ninth. A one signifies non-operating status for a particular day-unit-vehicle, while a zero denotes no restriction. If no data are entered, unremitting operations are presumed throughout the 65-day period.

Sample Data: Operation is interrupted by weather or command restriction on only five days at Unit #1. Neither Vehicle Type #1 nor #2 may operate on the 3rd and 17th days; the Vehicle Type #1 is also held back on day 20 and Type #2 on days 8 and 22.

COMMUNICATIONS SYSTEMS INPUT DATA
Card Type #31



These cards permit the user to define resource deliveries from the CONUS (i.e., outside the theater). The format permits the user to specify the destination and time of arrival of each shipment from CONUS, and the nature of the cargo. The destination and time need be specified only on the first of the cards defining the contents of a shipment, since the cargos specified on all subsequent Type #31 Cards are delivered at the same time and place until a new destination is encountered.

The maximum number of items that may be defined with a single entry is 250 (except for munitions and accessories, where 6250 items are permitted), but any number of identical entries are permissible with the same shipment. For POL, 100 units are delivered for each unit entered on this card type; if the unit of measure is tens of gallons, an entry of 50 on this card would direct the delivery of 5 thousand gallons--i.e., 50 × 10 × 100. (For POL, "type" is normally zero; if Type = 100, shipment is additional storage capacity.)

For personnel only, this card type may also be used to withdraw a specified quantity of specialists of a given type. To do this, the personnel type is entered as a negative value as a signal that the quantity is to be interpreted as a withdrawal.

This card type is also used to change the NRTS policies of a unit, but can only be used when no GSRF is simulated. Such a change might be desirable, for example, when general support repair facilities become available for a division deployed to the theater. The time to effect the change is signaled by delivery of a Type #3250 Part (Class #3) to the appropriate unit. At that time, the NRTS data that had been entered with Type #23/20x Cards are replaced with the data submitted on the #23/30x Card Types and stored in the POLICY array.

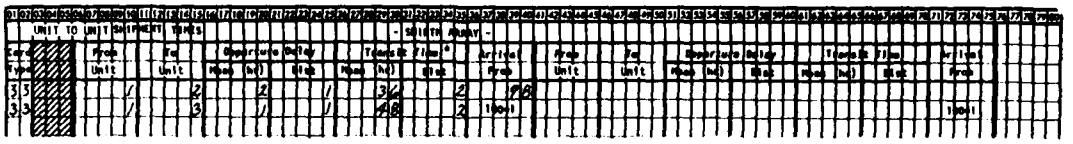
Sample Data: These two cards specify that Unit #1 is to receive a shipment from CONUS at 1700 on day 5. Included are five Type #7 Personnel, four Type #3 Spare Parts, 250 unassembled Type #4 Munitions, 50 Type #11 Accessory, and 1.2 thousand gallons of POL. Note that the arrival time and destination appear on only the first card. The third card indicates that four Type #1 Vehicles are to be moved to Unit #2 at 2100 on day 7.

Card Type #32

These cards define the daily intratheater transportation schedule. The nominal departure times for all links in the transportation network may be specified.

Sample Data: This card image indicates a daily shipment at 1700 from Unit #1 to Unit #2 and a shipment every other day at 1400 from Unit #1 to Unit #3. When shipments are not daily, the day for the first shipment is picked at random.

Card Type #33

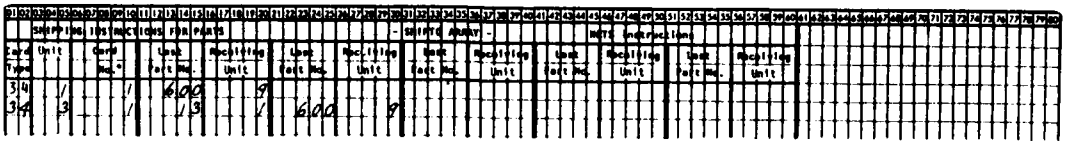


These cards, in conjunction with the Type #32 Cards, describe the intratheater transportation system. For each unit combination the user may specify the expected departure delays and their distributions, and the transit times and their distributions. The chance that a shipment is lost (to enemy action or mines?) is also entered with these cards.

Sample Data: These data indicate that all intratheater shipments from Unit #1 to Unit #2 leave an average of two hours late and take 36 hours on the average to reach their destination. The actual departure delay and transit time are determined by random selections from Distributions #1 and #2 respectively. There is a two percent probability that each shipment is lost enroute.

Note that for shipments from Unit #1 to Unit #3 the arrival probability was not entered, since the default value is 100 percent, and no losses are expected along that route.

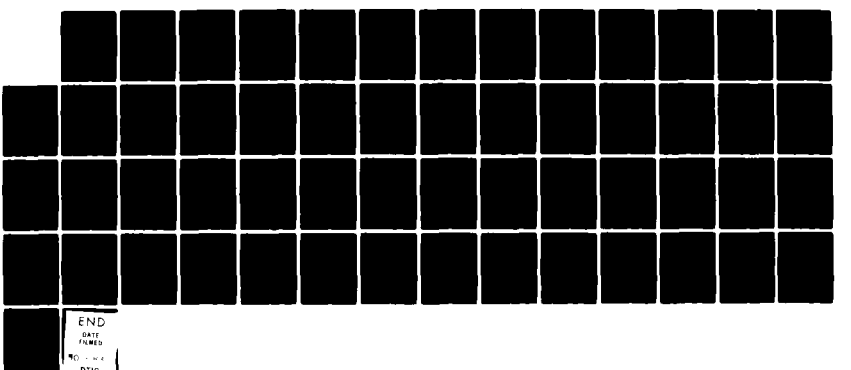
Card Type #34



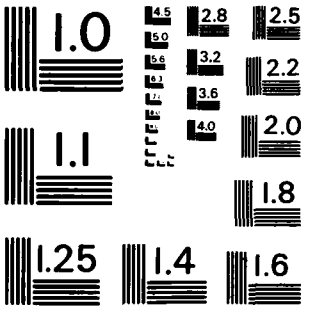
These cards provide the instructions for each unit for the disposition of NRTS parts. The entries delimit those part numbers that are to be NRTSed to other units. For example, all parts numbered from #1 to the first part number are NRTSed to the first unit listed, all subsequent part numbers up to and including the next part number are NRTSed to the next unit, etc. If all NRTSed parts are to go to a common unit (i.e., a GSRF) only one entry would be necessary--i.e., the highest relevant part number and the repair unit number. If parts are to be NRTSed to different units, the part numbers should be organized into contiguous groups to avoid exceeding the SHIPTO array capacity of 20 groups. Parts to be NRTSed to CONUS are indicated by a unit number that exceeds the maximum number of units by one (i.e., MAXB + 1).

Sample Data: This card indicates that whenever Parts #1 thru #600 are NRTSed at Unit #1 they are all to be shipped to CONUS (i.e., MAXB + 1). At Unit #3, Parts #1 thru #13 are NRTSed to Unit #1 and Parts #14 thru #600 are NRTSed to Unit #8.

AD-A132 686 AURA (ARMY UNIT READINESS/SUSTAINABILITY ASSESSOR) 2/2
USER'S MANUAL VOLUME 2..(U) RAND CORP SANTA MONICA CA
R SHISHKO ET AL. JUN 83 RAND/N-1988-MRAL
UNCLASSIFIED MDA903-83-C-0047 F/G 15/5 NL

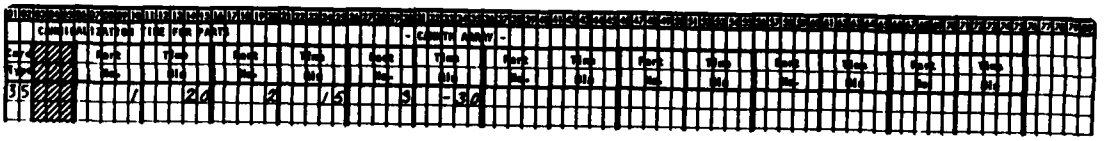


END
DATE FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

Card Type #35

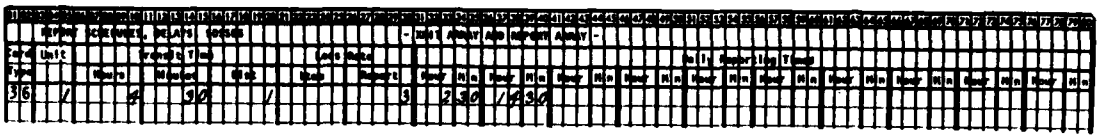


These cards provide the user an opportunity to specify a time different from the default value that is required to cannibalize a part. For those parts that have had a cannibalization time entered, the nominal task time for handling the relevant task will be increased by this time, when the required part must be acquired by cannibalization. If the entry is "-1," the part may not be cannibalized. If the entry is negative but not "-1," the part may not be cannibalized except when the number of vehicles in the unit that require the part exceeds DOCANN; in that case the nominal task time is increased by the absolute value of CANNTM to account for cannibalization.

If a value is entered for an SRU, the time required to diagnose and replace that SRU is increased by the entry if an LRU is disassembled to obtain the required SRU. If no value is entered, the default is one-half the nominal time for that SRU.

Sample Data: These data indicate that only 20 additional minutes are required to obtain a #1 Type Part by cannibalization, rather than the 36 minute default (i.e., the 25 TTU task time for Task #2; see Card Type #5). For Type #2 Parts a time of 15 rather than 30 minutes is indicated. Part Type #3 cannot be cannibalized unless the number of vehicles that have this part missing exceeds five.

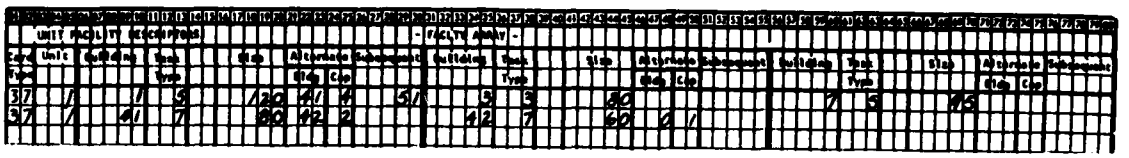
Card Type #36



Management of theater resources may be based upon imperfect information. These cards permit the user to define periodic unit-by-unit resource status reports that may be late, imperfect, canceled, or lost. Each unit reports its current resource status each day at times specified by the user. The arrival time at "Corps or Theater Headquarters" is controlled by the submittal time and the uncertain transit time. The likelihood that any element of the transmitted data is received is governed by the "Item Loss Rate," and the likelihood that the entire report is lost in transit is governed by the "Report Loss Rate." The transit times must be such that reports are received before the next one is transmitted; if this rule is violated, the transit time will be shortened appropriately, and the change will be noted in the output listing.

Sample Data: These data specify that Unit #1 reports to the control authority at 0230 and 1430 and that the reports arrive an average of 4 hours and 30 minutes later (the variance is controlled by Distribution Type #1). There is a three percent chance that the report is lost in transit.

UNIT FACILITIES DATA AND ENEMY AIR/ARTILLERY ATTACK DATA
Card Type #37



Card Types #37, #38, and #39 jointly describe the size of the critical facilities in each unit, the procedures and resources needed to restore the facilities to an operational condition when they have sustained damage, and the relative priorities for repair. The sizes and designations of the repair procedures for the various facilities are stored in the FACLTY array, and the resource requirements for each type of repair procedure are stored in the CERQTS array. The repair priority for each facility is stored in the CEPRTY array and it is *mandatory* that all facilities be represented in that array, even though some of them are not to be considered for repair. A facility *may* be restored to an operational condition using one repair procedure, or it may require a sequence of repair procedures. The time and resources required for each of these procedures is determined by the extent of the damage that was sustained.

The Type #37 Cards describe the size of the critical facilities in each unit (other than vehicle shelters) and specify the types of procedures that are to be used for repairs to each facility. Facilities (e.g., buildings) of like function in several units should all be identified with the same building number. Should a work center (shop) that deals with vehicle maintenance be located in a building, that facility must be given a "building" number identical to the "shop" number. If the repair of any of these facilities can require an additional repair procedure subsequent to that listed for the facility, the data describing those procedures are also stored in (otherwise unused) columns of the FACLTY array; each such listing defines the type of procedure and the effective "size" of the facility.

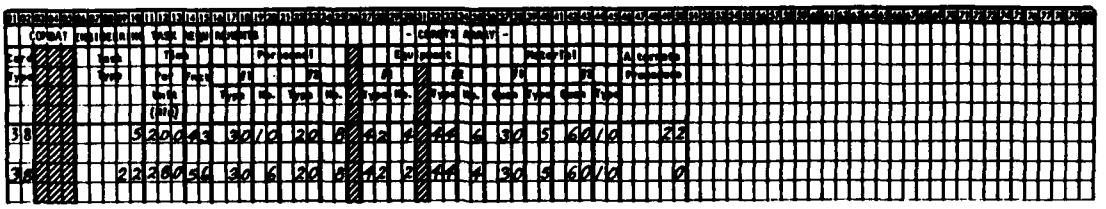
The "size" of the facility is meaningful in the context of the repair requirements specified with Card Types #38; the time to repair a facility sufficiently so it is functional is defined in terms of the required reconstruction (percent damage × size).

The work consigned to some shops may in fact be carried out at more than one location, and thus a unit's capacity for the activities assigned to those shops would not be entirely dependent upon a specific facility not being damaged. When this situation exists, the alternative locations for the activities of any particular type of shop are designated with the Type #37 Cards, along with an indication of the task capacity at each location. When this is done the repair capacity for parts and equipment in such a shop is equal to the sum of the capacities specified for each of the separate locations that remain undamaged following an attack. Maintenance personnel and other resources engaged in such activity at the time of an attack are assumed to be distributed among the several locations in proportion to their preattack repair capacities.

Sample Data: The first card specifies the nature of the reconstruction that would be required and the size of the facility for each of three facilities at Unit #1; two involve #5 Type construction and one involves #3. In addition, when the work required using the #5 Type restoration procedure has been completed on Shop #1 (Building #1), subsequent work may be required, as defined by the data filed for Building #51 in the FACLTY array; that work would use the #7 Type of work procedure.

The sample also illustrates the specification of a distributed shop capacity. In this instance the parts and equipment repairs consigned to Shop #1 are distributed among Buildings #1, #41, and #42; their respective repair capacities are 4, 2, and 1.

Card Type #38



The resources required for combat engineering reconstruction are summarized on these cards. Each task type defines the resource requirements for a particular reconstitution procedure. Each procedure is expressed in terms of a level of effort for manpower and support equipment; building material requirements are assumed to be proportional to the level of damage that was sustained, and the time required to execute a repair procedure is related to the damage in a more complex fashion as noted below. The basic procedures specified with the Type #37 Cards should be followed whenever sufficient resources exist; the first alternative should be used to specify a procedure that requires fewer combat engineer personnel and support equipment. (Since a unit may have no more than 320 units of personnel of a particular type, the personnel requirements for these tasks may have to define a unit of personnel as several persons.)

When a facility may require a sequence of two or more reconstitution procedures for it to be restored to operational status, the time and resource requirements for each procedure are determined on the basis of the damage reported in the DAMAGE array data for each procedure or building and the size of that building as defined by the #37 Type Cards. Only when all required procedures have been executed in sequence is the facility returned to operation.

The repair time and material requirements entered on the Type #38 Cards should be the requirement for one size-unit of reconstruction. The largest quantity of material that may be entered for a unit-task is 320. The time function relates the total task time to the unit-task time (as outlined in the FTIME subroutine). It permits the total task time to be expressed as the sum of a startup time and a damage dependent time. This function is defined as:

$$C = 12 \times P + (B - 1)$$

and the total task time is:

$$T = \text{Delay (B)} + \frac{(\text{Repair Time})}{(\text{Unit Damage})} \times (\text{Units of Damage})^{g(P)}$$

where

Delay (B) = 0,1,2,3,4,6,8,12,18,24,36,48 hours for B = 1 to 12

and

g(P) = 0.5, 0.75, 0.9, 1.0, 1.1, 1.25, and 1.5 for P = 1 to 7

Alternative procedures are also filed in the CERQTS array.

Sample Data: These two cards indicate the primary and alternative procedures for Type #5 reconstruction jobs. The primary procedure uses ten Type #30 and eight Type #20 Personnel and four pieces of Type #42 Support Equipment and six Type #44. Thirty units of building material Type #5 and 60 units of Type #10 are required per unit of damage. The time per unit of construction is 200 minutes and varies as a function of the amount of reconstruction as specified by function FTIME #43; i.e., if 40 percent damage were sustained by a facility that is 60 units in size, the total time for reconstruction would be

$$240 + (200/3) \times (.40 \times 60)\ 0.9 = 1404 \text{ TTU}$$

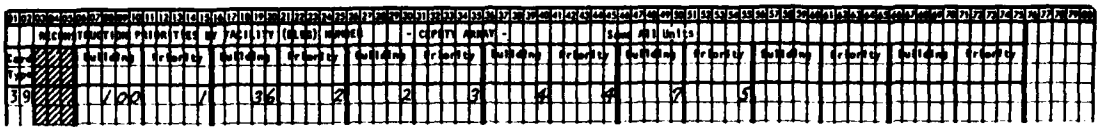
or about 70 hours.

If the alternative procedure were used, fewer personnel and equipment are required but the time would be increased (Function #56) to

$$360 + (280/3) \times (.40 \times 60) = 2600 \text{ TTU}$$

or 130 hours.

Card Type #39

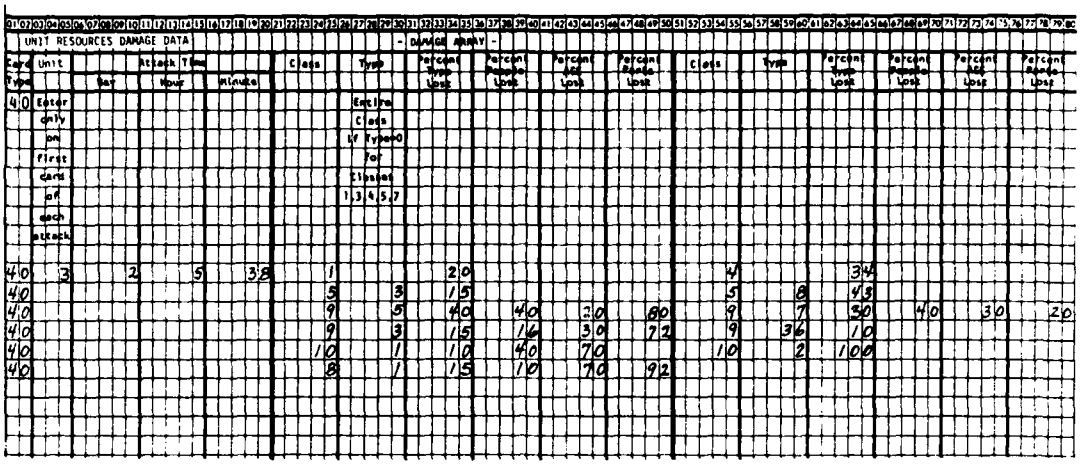


The order of importance of the facilities and functions at a fixed-location unit is specified with these cards; the priority is the same for all such units. For each facility (or building) number that has been specified at a unit (including alternative facilities but exclusive of facility numbers used to define a sequence of necessary tasks), the priority of that facility must be entered in this priority list, even though repairs are not contemplated.

Facility #36 has been set aside (by program logic) with unique dimensional sensitivity; the entry-pair "36 1" would specify its reconstruction as the first priority combat engineering task; "2 3" would specify that reconstruction or reconstitution of Shop #2 was the third priority task.

When a unit has been attacked and the total damage established (in subroutine BOMB), AURA first tests whether the combat engineering resources are adequate to initiate reconstruction or reconstitution of all damaged facilities of higher than or equal priority to that of facility CRBLDG. If the resources are available, all work is started; if they are insufficient, resources for the first alternative repair procedure (when specified), or alternatives thereto, are allocated to each damaged facility until the combat engineer personnel are all assigned. By specifying fewer resources and longer times for the alternative repair procedures, this use of CRBLDG results in the available work force being assigned to a larger proportion of the more critical tasks.

Card Type #40



UNIT RESOURCES DAMAGE DATA — DAMAGE ARRAY

Card Type	Unit	Attack Time: Day	Hour	Minute	Class	Type	Percent Type Loss	Percent Blanket Loss	Percent Add Loss	Percent Blanket Loss	Class	Type	Percent Type Loss	Percent Blanket Loss	Percent Add Loss	Percent Blanket Loss
40	Enter only on first card of each attack					Enter Class or Type=0 for Classes 1,3,4,5,7										
40	3	2	5	38	1		20				4		34			
40					5	3	15				5	8	45			
40					9	5	40	40	20	80	9	7	50	40	30	20
40					9	3	15	16	30	72	9	36	10			
40					10	1	10	40	70		10	2	100			
40					8	1	15	10	70	92						

These cards prescribe the damage inflicted by enemy air/artillery attacks on bivouac areas. They permit the user to define the time of the attack and the level of damage sustained by each of the many types and several classes of resources. Such data will need to be developed from a distinct set of calculations. The companion TSARINA computer model (derived from the AIDA airbase damage model) permits the user to generate the appropriate data for direct input into AURA. The procedure for introducing damage data for multiple trials, either directly from TSARINA or with separate sets of card images for each trial, are explained in the comments in subroutine INPUTC.

The order in which these data must be entered is important. An attack is denoted by entering the time and location of the attack in the "J" field and in the next three fields. All subsequent Type #40 Cards are associated with the same attack until an entry is encountered in the "J" field.

The percent losses experienced by each class and type of resource may be specified using these cards; however, if the user wishes to assume that all members of a given class sustain the same level of attrition, a type number should not be entered; when that is done, all members of that class suffer a common loss percentage. For the first

seven classes of resources, only the class, type, and percent loss may be entered. For vehicles and facilities, additional loss rates may be entered that express the percentages of the personnel, equipment, and parts in the facility that are destroyed by the attack. Entries for these categories will depend upon the user's assessment of the available warning of attack as well as active and passive defenses.

The specification of damage and destruction to vehicles and of the damage to shelters requires at least three sets of entries. The first two are entered as Class #10 data. The "percent type lost" for "Type #1" is interpreted as the percentage of the shelters that are not designated for "special" duty that are destroyed in the attack. The entries under personnel and equipment are interpreted as "the percentage of the vehicles in those shelters that are damaged when the openings are unobstructed," and "the percentage of the unsheltered vehicles that are damaged," respectively. The entry for "percent type lost" for "Type #2" is interpreted as "the percentage of the vehicles that are damaged in the attack that are not reparable." The entries under personnel and equipment are interpreted as "the percentage of the "special" duty shelters that are destroyed" and "the percentage of the vehicles in the special duty shelters that are damaged when the openings are unobstructed".

The final entries are the Class #8 data. The "percent type lost" for "Type #1" is interpreted as "the percentage of the vehicles that are damaged in regular shelters when the ends are blocked" and as percentage of the personnel, equipment, and parts associated with damaged vehicles that are lost. The "percent type lost" entry for "Type #2" is interpreted as "the percentage of vehicles damaged in special shelters when their ends are blocked."

Sample Data: These several cards specify the damage inflicted on Unit #3 (operating from a fixed location) by an attack at 0538 on day 2. The first card specifies that 20 percent of all types of support personnel (Class #1) and 34 percent of all types of munitions (Class #4) are destroyed; all types are affected since no type is specified. The

second card indicates that 15 percent of Accessory Type #3 and 43 percent of Accessory Type #8 were lost.

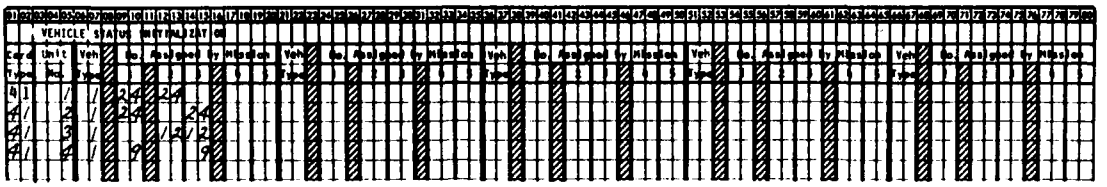
The third and fourth cards indicate that 40 percent, 30 percent, and 15 percent of Facilities #5, #7 and #3, respectively, were damaged and must be repaired to restore the functions associated with those shop facilities. The percentages of personnel, equipment, and parts that were destroyed in each facility by the attack are noted. The fourth card also indicates that the unique facility[3] is closed and that 10 hits must be repaired to return it to operation.

The last two cards specify the damage sustained by the shelters (if any) and vehicles in the unit at the time of the attack. Note that the special data (Class #10) precede data for the vehicles (Class #8). The entries for the Type #1 special data specify that 10 percent of the shelters are destroyed, that 40 percent of any vehicles that are only partially sheltered are damaged, and that 70 percent of the vehicles outside of shelters are damaged. The entry for the Type #2 special data specifies that 100 percent of the vehicles that are damaged are not reparable; since no "special" shelters have been defined for this illustration, there are no other entries on this card. The last card specifies that 15 percent of the vehicles that are sheltered are damaged, and that 10 percent of the personnel and 70 percent of the equipment associated with the damaged vehicles at the time of the attack are lost; for those vehicles that are not reparable, 92 percent of the parts can not be recovered by salvage operations.

These various damage data may be entered in any order except that the special damage data (Class #10) must precede the vehicle damage data (Class #8).

[3] The facility designated #36 is interpreted as a runway for aircraft operations.

INITIALIZATION OF VEHICLE AND SHOP STATUS
Card Type #41

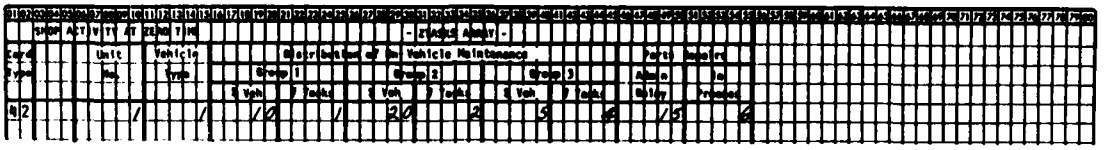


These cards permit the user to initiate the simulation with the vehicles and shops in the conditions that might be expected if war were to break out following a period of warning and vigilence. All vehicles are ready to be sent on specified missions, fully loaded with the preferred standard combat load and configuration for those missions. No vehicle maintenance tasks, parts repair, munition assembly, or combat engineering tasks are in process, waiting, or interrupted. These latter conditions may be modified by Card Type #42.

These cards specify the numbers of each type of vehicle that are ready for each of the several missions for each unit. They must be entered after Card Type #20, and the units and the vehicle types *must be entered in the identical order in which they are specified on Card Type #20*.

Sample Data: This card specifies that at the beginning of the simulation half of the vehicles on each unit are assigned to one of two missions; vehicles are configured for Missions #1 and #2 at Unit #1, and for Mission #1 and #3 at Unit #2, etc. These data must be input in the identical unit-vehicle order used with the #20 Card Types.

Card Type #42



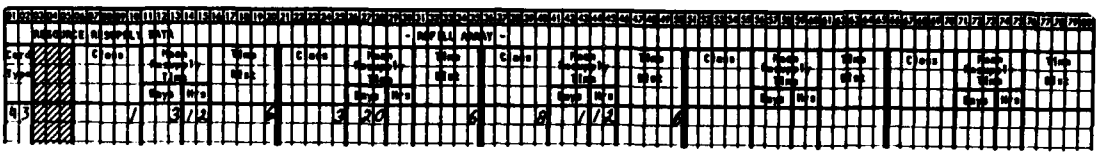
These cards can be used in conjunction with Card Type #41 to initialize vehicle maintenance activity at the beginning of the simulation. After Card Type #41 has been used to specify that all vehicles are ready to be sent and that there is no activity ongoing in the shops, these cards will modify those conditions. To simulate the existence of ongoing unscheduled on-vehicle tasks, the user may specify a three-part distribution. Each part is defined as a fraction of a given type of vehicle at a particular unit, and a number of tasks; thus one might specify that 10 percent of the vehicles have one unscheduled task to be completed, 20 percent have two tasks, and 5 percent have four tasks. At initialization, a random number is drawn for each vehicle to see if work remains, and how much. If so, tasks are selected at random, in proportion to their nominal probability of occurrence; when initiated, the time remaining to completion is taken as a random portion of the total task time.

The user may also specify a level of parts repair activity. Two numbers can be input for each vehicle type and unit; the first is the number of repair tasks to be placed in the administrative delay, and the second is the number that are placed in-process or waiting. These activities are selected in proportion to their nominal probability of occurrence, and the portion of the time remaining is selected with a random number.

Sample Data: This card image indicates that Type #1 Vehicles at Unit #1 should be assigned ongoing maintenance activity at zero-time according to the distribution discussed above. This card also directs that 21

local parts repair jobs are to exist at zero-time--15 in the administrative delay queue and six in process or waiting for resources to be started.

Card Type #43



These cards permit the user to simulate the requisitioning and resupply of resources that are lost in combat or during a bivouac area attack (either on an operating unit or on a rear DS/GS maintenance unit), and parts that are not reparable in the theater. For those classes of resources that are specified with these cards, such losses are replenished from CONUS after a delay that is controlled by the mean resupply time and the time distribution. The numbers that designate the various resource classes are:

1 - Support personnel	5 - Accessories
2 - Support equipment	6 - Building materials
3 - Parts	8 - Vehicles
4 - Munitions	9 - Crewmen

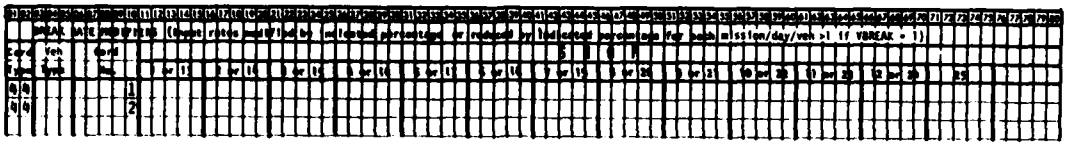
Note that the number "9" is not used to designate facilities; this is the only exception to that usage in AURA. Also, POL is not included at this time

Whenever losses are suffered by any type of resource of the classes that are entered, a resupply shipment of the same quantity and type is scheduled to arrive at the location that suffered the loss after an appropriate delay. If the stocks available for resupply are limited, the limits for each type of resource are specified with the "J = 99" version of each of the resource stockage cards (i.e., Card Types #20 through #27).

Sample Data: With these illustrative entries, support personnel that are lost to attack would be replaced in about 3-1/2 days; parts that are lost or are not reparable in the theater could be requisitioned from

CONUS with replacement expected in about 20 days. Vehicles lost in combat or from rear area attack would be replaced in approximately 36 hours. In each case the actual resupply time is established with a sample from the #6 Distribution (i.e., about plus-or-minus 40 percent, relative to the mean).

Card Type #44



The probability that the various unscheduled on-vehicle maintenance tasks are required after a given mission are entered using Card Type #7. The normal data available for estimating these probabilities, or breakrates, are usually derived from peacetime experiences at low training rates. Limited evidence suggests, however, that the perceived breakrates in wartime, at higher activity levels, may not be as high on a per mission basis. These cards permit the user to reflect his perceptions of such experiences in the simulation on a shop by shop basis. The breakrates may be reduced (or increased) from the nominal values for whichever vehicle types and shops are designated. Two options are available; if the control variable VBREAK (Card Type #3/2) is zero, the entry is interpreted as the percentage of the nominal breakrate (as entered with Card Type #7) that should be applied. Plausible determinants might be miles traveled or rounds fired per mission. If VBREAK is unity the entry is interpreted as the percentage reduction in the breakrate that is experienced for each mission when the number of missions per day per vehicle exceeds one. If no value is entered (100 percent of) the nominal values on Card Type #7 will apply.

Card Type #45/1

When personnel and support equipment of the same kind are assigned to different unit organizations, it is necessary to designate each subset by a different number in AURA, as illustrated in Fig. 7. The Type #45/1 Cards provide AURA the necessary data with which personnel of common skills can be identified. Identical personnel types may be assigned to up to three company organizations and a battalion organization. The personnel type numbers that are identified with the on-vehicle maintenance task requirements on Card Types #5 and #6 should be entered under "Personnel Type"; these personnel designations are assumed to be available to support the first company. The AURA personnel type numbers for the same type of personnel assigned to the second and third companies should be entered in the next two fields; those assigned at battalion level are entered in the fourth field. These numbers, when entered on this card type, *must* appear in an *ascending* sequence.

If some personnel types are not assigned at company level and all demands are met from a common unit pool, the user need enter the personnel type number only in the first field; the same number will be entered automatically into the other fields. Contrarily, any personnel type that is identified in the second, third, or fourth fields as an equivalent type should not be entered elsewhere in the first field.

These data are used not only to identify within AURA which personnel types are to be called on when a particular on-vehicle task arises in the second or third company, they are also used when personnel of a given type are lost or gained; the program automatically cross-levels personnel strength in the several subgroups so that their relative sizes are stable, i.e., MOS strength per vehicle is approximately equal.

Sample Data: The entries on the first card indicate that Types #1 and #2 Specialists are assigned to Company #1 and that their counterparts in Company #2 are Types #21 and #22. There are also some Type #2

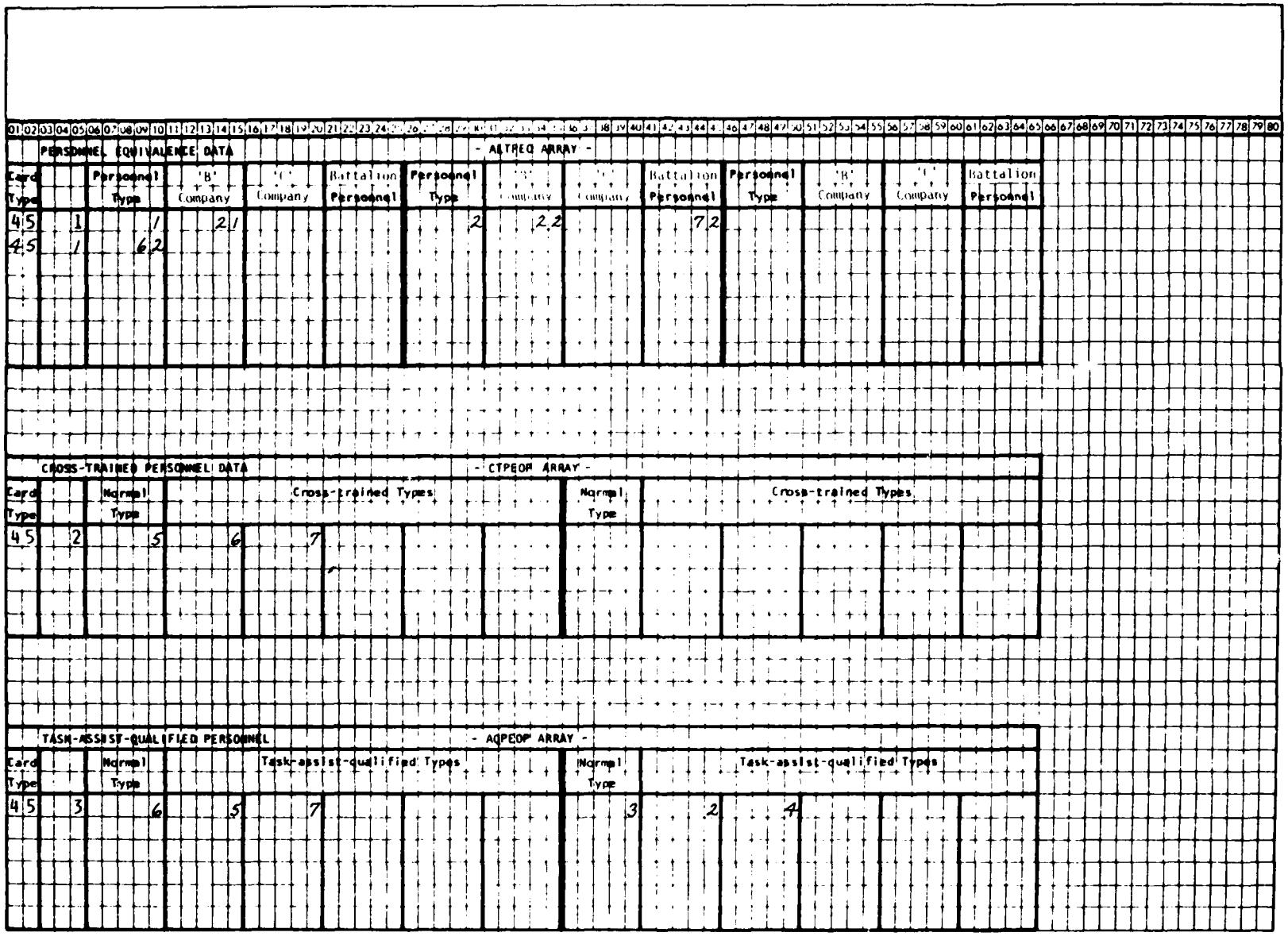


Fig. 7 — Personnel equivalence and substitutability data

Specialists assigned at battalion level; they are designated Type #72. The second card indicates that there are no equivalents for Type #62 Personnel; all such personnel can be called upon for work in any company of the battalion.

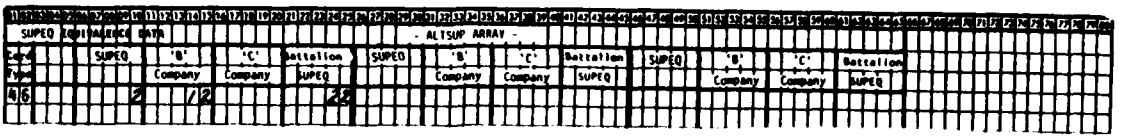
Card Types #45/2 and #45/3

Personnel may be cross-trained to handle some or all of the tasks normally assigned to other specialists; others may be trained sufficiently to assist the nominal specialists. Card Types #45/2 and #45/3 provide the means by which the user can designate the personnel types that have been trained to replace or assist various MOSs. Up to five types of alternative specialists may be specified in each category; when personnel are organized into companies, only the designators for those in the first company should be entered.

Sample Data #45/2: This card indicates that Type #6 and Type #7 Personnel can replace Type #5 Personnel and that Type #3 Personnel can replace the #2 Types.

Sample Data #45/3: Types #5 and #7 Personnel are trained to assist Type #6 Personnel on designated tasks, and Types #2 and #4 can assist #3 Types.

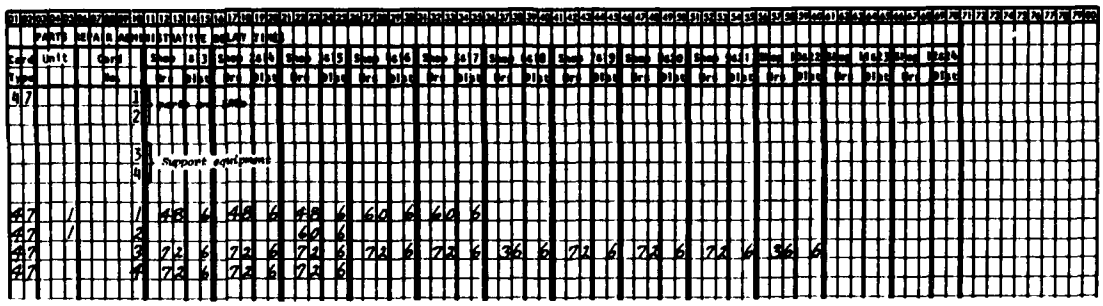
Card Type #46



These cards provide the same kinds of information on support equipment as are provided for personnel with Card Type #45/1. The same constraints and objectives apply for equipment as for personnel.

Sample Data: These data indicate that a particular type of support equipment is assigned to both of two companies and at battalion level; they are designated Types #2, #12, and #22 at these locations, respectively.

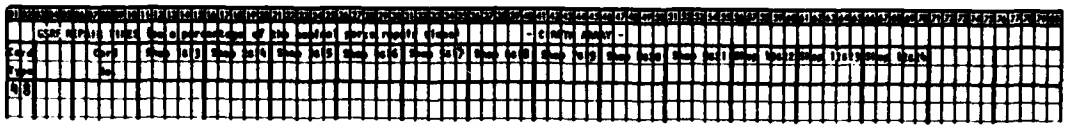
Card Type #47



These cards permit the user to specify the length of the administrative delay for each shop at each unit for the repair of both parts and support equipment. These delays should be used to reflect the times required to process the necessary paperwork and for intra-unit transportation as well as the delays imposed by the need to await the arrival of necessary component parts, e.g., nuts and bolts, that are not tracked in AURA. When a delay is specified for parts or support equipment, repair initiation is deferred until the delay has concluded, unless the control variable EXPED has been set to a value greater than unity. In that case, the delay will be reduced to 1/EXPED times the nominal value when the unit has no serviceables.

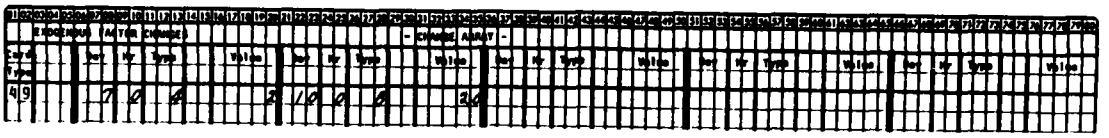
Sample Data: The sample indicates a 48-hour parts repair delay at the first three shops, and 60 hours at Shops #4, #5, and #15; the actual delays are all selected from a Type #6 Distribution. For equipment the nominal delays are 72 hours at all shops except #6 and #10, where they are only 36 hours.

Card Type #48



Since the environment and procedures at a GSRF (or DISCOM) could differ substantially from the conditions at an operating unit, this card is provided to permit the user to specify a percentage by which the times for all the parts repair jobs at a given shop will be modified when they are conducted at a GSRF.

Card Type #49



These cards permit the user to change many of the key control variables or array elements at a time subsequent to the initiation of the simulation. The mechanism for accomplishing these changes is managed in subroutine MODIFY, where the specific kinds of changes to be used must be encoded. The changes supported with the current version of AURA include NTYPE, PRINT, FILLAC, SLEEP, REST, HURRY, etc.; the complete list of 20 variables can be noted in that subroutine. Each change type number is the label in the code for that variable divided by 10. By changing HURRY, the user can vary task efficiencies in a stepwise fashion over time for different task types and at different units. The procedures for using this feature can be inferred from the comments in the code at label 210 in subroutine MODIFY.

These time-dependent change data are stored in the CHANGE heap; entries may be introduced exogenously during initialization using Card Type #49, or adaptively during the course of the simulation, with a call to the NEWVAL entry point in subroutine MODIFY. Several changes may be entered with each card; data include the day and hour for the change, as well as the type of change and the new value. As illustrated in the MODIFY subroutine, array elements may also be changed in this fashion by "packing" information regarding the appropriate array element with either the "type" entry or the "value" entry.

AURA, as currently written, provides a few illustrative possibilities for adaptive control of the simulation in subroutine MODIFY. Furthermore, subroutine ADAPT, which is called at midnight each day, provides a convenient context within which to introduce the logic necessary to schedule changes that would subsequently be activated with a call to NEWVAL in MODIFY.

Sample Data: The sample entries indicate that (1) the value of the variable PRINT (Change Type #4) is to be changed to 2 at the beginning of the seventh day, and (2) the value of REST (Change Type #8) is to be changed to 60 minutes (20 TTU) at the beginning of the tenth day.

INPUT-DATA LIST CONTROL CARD

The termination of the basic input data entered with Card Types #1 through #49 inclusive is denoted with a blank Card Type #99. This card is followed immediately by the Input-Data List Control Card. It controls which of the input data are to be reprinted as they are stored in the various storage arrays after program initialization. A "1" in any column between 5 and 45 inclusive (except cols. 7, 11, 29, 32, 33, 34), will direct a listing of the data that were entered using card types of the same number; all time data will have been converted to AURA time units (TTU) and in some cases the data will have been packed or repacked. The control data entered with Card Types #1 through #4 are summarized on the first page of the output.

The Type #50 Cards, which input the mission demand data, will follow this card.

MISSION DEMAND DATA

Card Type #50

Several different types of mission demand data are entered with this Card Type--unique demands, periodic demands, and overwatch levels, as well as changes in these demand data; several of these are illustrated in Fig. 8. To limit the size of data storage arrays, AURA permits the mission demands to be read at user controlled intervals, as will be explained.

The user may specify mission demands for specific days and at specific times, or he may specify a set of mission demands that repeat every day, each with a specified probability and at times selected from a specified (10 hour maximum) time block. Furthermore, up to 31 identical missions may be demanded within the same time block with a single periodic demand entry. The option for recurring or periodic mission demands provides the analyst a convenient means of specifying a demand pattern that varies randomly from day to day, as might be expected in a wartime environment. The user may also employ any combination of these options. The periodic mission demands must each be numbered by the user in the J-field (i.e., cols. 3-5); the likelihood, in percent, that the mission is demanded on any given day is entered in columns 26-30.

The number of vehicles that are to be placed on overwatch or in reserve are also specified with Card Type #50; in this case the "Start Time" is interpreted as the time at which the overwatch requirement is to start. These cards are distinguished by a "-1" entry for "Hours Notice"; the demands are not periodic but rather persist until changed.

Mission priority is denoted with an integer from one to six inclusive; priority number one is the highest priority. Priorities two and four are reserved to denote demands for vehicles that have been placed on overwatch or reserve. Demands for dispatching reserve vehicles are presumed to occur without advance notice (i.e., the "Hours Notice" entry should be zero).

Certain other conditions or constraints are noted in the format illustration. If the minimum mission size and the final unit are not entered, they are automatically set equal to the maximum mission size

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MISSION DEMAND DATA — FLTMQT ARRAY — Periodic Only

Card Type	Per. Sched No.	Initial Unit	Vehicle Type	Mission No.	Priority	Demand Prob (Enter only for periodic mission schedules)	Max Element Size* (≤ 16)	Min Element Size* (If zero, set to max)	Hours Notice (Set to zero to hold overwatch vehicles; Set to +1 to set/change overwatch level)	Final Unit** (If zero is set to initial unit)	Mission Time Day (Do not enter for periodic missions)	Hr	Min	No. of Missions	Block Time (10 Hr Max) Hrs	Min
50		2	2	3	1		8	6	6		7	19	15			
50	7	3	1	1	3	75	6	5	10	3		6	30			
50		1	1	2	2		4		-1		4	8	00			
50		1	2	2	1		4	4	8	1	4	12	00			
50		2	1	3	1	200	4	4	8	2	4	12	00			
50		3	2	1	1	200	4	4	8	3	4	12	00			
50																
50		2	2	3	1	-4	-4	3	2		7	17	15			
50																
50	9	1	1	2	2	50	2	2	0	1		9	30			
50	10	2	1	2	3		2	2	2			8	00	4	2	30
50	11	3	2	2	3		2	2	2			8	00	4	2	30
50	12		1	1	1		3	3	8			20	00	4	1	00

*Elements could be platoons (e.g., 4 or 5 vehicles) or tubes (e.g., 1 vehicle).

**Use only if cross-attachment changes during mission.

Fig. 8 — Mission demand data

and the initiating unit, respectively. The desired start time is entered in hours and minutes (e.g., 1545 for 1545 hours).

Several sets of mission demand data may be treated as a single composite mission, in which all elements must satisfy at least the minimum mission size requirement, or the entire mission will be canceled and all ready vehicles placed in the spare queues. With this feature the user may demand, for example, four tanks from one unit, four armored personnel carriers from another unit, and four self-propelled howitzers from a third unit. To demand a composite mission, card images must be sequential, and all but the first card image will be identified with 200 for the "demand probability." Up to six submissions may be combined into a single composite mission with up to 50 vehicles, in total. All elements of a composite mission must be scheduled for the identical start time and the several card images defining the composite mission must be entered one after the other. The set of card images defining a composite mission may specify either a unique or periodic demand. If they are a periodic demand, the time-block feature and multiple demand feature normally available with such types of demand may not be used.

It is sometimes of interest to be able to simulate a "go-when-ready" demand policy. This may be done by using periodic demand cards to specify several missions of, say, 12 vehicles (with as few as one acceptable) every hour and also by permitting vehicles to be started up to an hour late. Whenever a vehicle completes maintenance during the operating day, there will be a demand outstanding that it can fill.

Mission demand data are entered at the time of program initialization and up to once a day thereafter. Those data to be read at program initialization time are terminated with a Card Type #99, specifying the first day for reading subsequent data in columns 3-5. If a day greater than one is entered in that field, the periodic missions will be rescheduled for the second day and other days before the one named; new mission data are read each day at 2000 hours.

Another special feature permits a mission to be reduced or canceled before it has been initiated, thereby simulating the effects of such changes. This feature is actuated when a negative mission size is listed for a mission. When that is done the entry for the "number of

hours notice" is interpreted as the number of hours before the mission that is to be reduced or canceled. Thus, if there is a demand for 12 vehicles at 1545, and a demand of -4 vehicles of the same type, for the same mission, and from the same unit at 1345 (with a two hour notice), then the 1545 mission demand is reduced from 12 to eight vehicles at 1345, and the minimum permissible size for that mission is the value entered after the value -4.

Whenever new mission data are read in (on the day specified by the preceding data terminator card) both unique and periodic missions may be demanded. As before, periodic missions will be numbered (cols. 3-5) and whenever a number previously used is entered, the new data replace the old. Each new set of mission data is terminated with a Card Type #99; the number of days before the next entry must be placed in columns 3-5.

AURA is now dimensioned so that 400 missions may be scheduled in any 24 hour period and 160 periodic missions may be stored at any one time.

Sample Data: These several cards illustrate the various mission demand options. The first card specifies a demand calling for eight Type #2 Vehicles (six minimum) to be sent from Unit #2 at 1915 on day 7; they are to be configured for Mission Type #3, which is a top (#1) priority mission. The demand is received at 1315 (i.e., 1915-0600) on day 7. Since no final unit is noted, the vehicle remains attached to the same unit.

The second card indicates a mission that is to be sent from Unit #3 with a 75 percent probability each day at 0630. Six Type #1 Vehicles (five minimum) are to be prepared for a Type #1 Mission; the demand for this third priority mission is received in the evening at 2030 (10 hours before mission time).

The third card specifies that as of 0800 on the fourth day, four Type #1 Vehicles will be maintained in reserve for Mission Type #2 at Unit #1. This second priority requirement stands until changed.

The next three cards jointly specify a composite mission to be made up of three platoons of four vehicles each from Units #1, #2, and #3 to be started at noon of the fourth day. The vehicle types and missions

vary from platoon to platoon. The demand is received at 0400 on the fourth day and the entire mission must be canceled if all 12 vehicles are not ready; to enhance the likelihood that cancellation will not be required, top priority (1) is assigned to this composite mission.

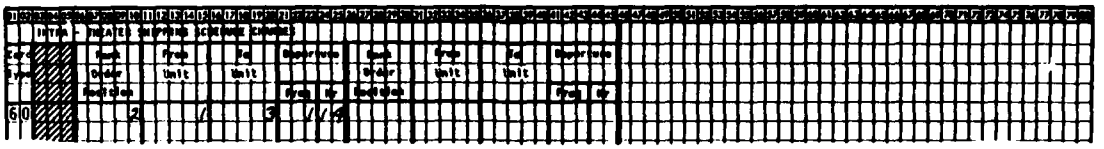
The seventh card exercises the mission demand revision option. This card specifies that at 1715 on Day 7 an order is received to reduce the mission size of a mission two hours later, by four vehicles (new minimum is three). Since the mission demand on the first card is for the same unit, vehicle type, mission, and priority and is at the correct time, it is reduced to four vehicles (i.e., 8 - 4).

The next card specifies a recurring demand on Unit #1; a demand without warning for two Type #1 Vehicles, configured for Mission Type #2, to be dispatched immediately at 0930. This demand occurs with 50 percent probability each day. These vehicles will be drawn from the reserve force generated by the requirement specified on the third card, if they are available.

The next to last two cards specify recurring demands for four two-vehicle missions from Unit #2 and from Unit #3; these missions are to be started each morning at times selected at random between 0800 and 1030. In all cases the demands are received only two hours before mission time. At Unit #2, Type #1 Vehicles are to run Type #2 Missions. A priority of 3 is specified for all of these missions. The missions will not be attempted unless both vehicles are ready.

The last card also specifies a recurring demand, but it differs from all other illustrations in that no unit is specified. This type of demand is permitted only when the control variables STATE and SELECT have both been initialized to one or greater. When that has been done, AURA will assign these demands for four three-vehicle missions between 2000 and 2100, to the unit best able to handle them. They may be assigned to one or more units, depending upon their capabilities.

Card Type #60



Unit-to-unit shipping schedules may be changed at the same time that changes are made in mission data by entering #60 Type Cards along with #50 Type Cards; in fact, only Type #60 Cards need be entered. The time for entering such changes is controlled with Card Type #99 as described with the Type #50 Cards.

To change any particular schedule, or to add or eliminate a schedule, it is necessary to know the total number of schedules already entered with the #32 Card Types, and the position of any schedule that is to be changed within that overall number. The order of data entry is (1) rank order position of schedule that is changed/added/deleted, (2) departure point (unit), (3) destination (unit), and (4) departure hour. If a schedule is to be added, its rank order position must be one greater than the existing number of schedules. Two sets of data may be entered with each Card Type #60.

If the departure frequency is entered as a zero, no further shipments are planned for that schedule, unless subsequently revitalized with another Type #60 Card.

Sample Data: These entries indicate that the original shipment schedule from Unit #1 to #3 (entered second on the #32 Type Cards) is to be changed from every other day to daily.

XX. DATA BASE FOR SAMPLE PROBLEM

The entries used in the explanations of the data input procedures in Section XIX were selected to illustrate some of the more complex features of AURA. The sample data base to be used here will be much simpler, involving only three units of battalion size operating a single type of hypothetical armored vehicle, and supported by one rear area maintenance unit (e.g., a FAST) for longer repair tasks than are tolerable in forward locations.

DICTIONARIES

One of the first tasks in developing an AURA data base is to create dictionaries for the various classes of resources to be simulated. These provide a bridge from the type numbers within each resource class (usually one or two digits) to the nouns that are recognizable to the nonmodeller. Below we show the dictionaries for the data base illustrated in this section.

The identifying number assigned to each resource type is arbitrary and is selected by the user. The only restrictions are that the numbers selected must be no larger than the relevant storage arrays, and the designators for combat engineer personnel and support equipment should be larger than (NOPEOP - CEPEO) and (NOAGE - CEAGE), respectively. In the present illustration the PEOPLE array is dimensioned for 200 types of personnel, and ten are reserved for combat engineer type. Consequently any type number up to 190 may be used for personnel who are not combat engineers. When two or more designations are used for the same MOS assigned to two or more subgroups (e.g., companies or batteries), the lowest numbered designation must be assigned to the first subgroup as shown. (See instructions for Card Type #21 and Card Type #45/1.) This rule applies to support equipment as well.

Table 2

EXAMPLE RESOURCE DESIGNATOR DICTIONARIES

Personnel Type	Description	Equipment Type	Description	Parts Type	Description
1	Tracked Veh. Mech.	1	Recovery Veh.	1	Power Pack
2	Electrician	2	A-Frame	2	Engine
3	Armament Mech.			3	Transmission
4	Recovery Veh. Driver			4	Radiator
5	Crewman			5	Alternator
				.	
				.	
				.	
				28	Hydraulic Pump
				29	Actuator

DATA ORGANIZATION

The simplest and least error-prone method of organizing data for an AURA simulation is to order the data input card images by their Card Type numbers. Similarly, the large data collections that define the various tasks are also best organized by ordering them by their task number; thus the on-vehicle tasks defined by Card Types #5 would be ordered by the task number appearing in columns 3-5. It is much easier to locate and check data entries when they are organized in this manner.

There are few mandatory rules regarding the order of data entry, but what rules there are must be observed; they are:

- The first card in the input card-image deck is either blank or has "1"s in the columns corresponding to the card types that are to be listed at entry time.
- Card Types #1 through #4 must be entered in numerical order and before any other card types. (Note the special rules regarding columns 3-5 of Card Type #1 and TEST on Card Type #2.)

- Card Types #20, #41, and #42 must be entered in numerical order. (Note special rules for entering vehicle missions on Card Type #41.)
- When resource data are not entered specifically for each unit, but take advantage of the convenience features described for these data, the resultant data base depends on card order.
- The mission demand data are entered using the #50 Card Types after all Card Types #1 through #49 are entered. The #50 Cards are preceded by a Type #99 Card and a card that controls input data listings. The Type #50 Cards are followed by a Type #99 Card specifying the data for the next addition or modification to the mission or intratheater transportation schedules. Subsequent changes to these schedules are specified with additional Type #50 Cards followed by another Type #99 Card specifying the number of days that should elapse before the next inputs are to be read, if any.

Figures 9 through 12 present the data-entry card-images specifying the sample problem discussed in this section. They are presented here as they would be organized for submission to the computer. The remainder of this section outlines the nature of the sample problem this data base is intended to address.

CONTROL VARIABLES

Card Type #1 designates, on Fig. 9, five trials of a 15-day simulation. Three operating bases with one vehicle type are to be simulated (NBASE = 4 and NTYPE = 1); crews are to be monitored (CREWS = 1), and no munitions are to be assembled (BUILD = 0).

Theater resources are not to be monitored centrally (AURA = 0) and spare parts arriving from CONUS will not be managed centrally (CONSIG = 010) using CMODE = 0. Because no personnel or support equipment are provided at the highest numbered unit (Unit #8--see Card Types #21 and #22), there can be no centralized parts repair. The attack damage data that will be entered were not generated by TSARINA (AIDA = 0).

```
!!!
```

```
 5 17   21   17  60   2 2
 5 56   2        20   2 1
 5 19   2    19  12   2 2
 5 57   2        10   2 1
 5 19   21   19  46   2 2
 5 59   2        32   2 1
 5 20   2    20   9   2 1
 5 21   31   21  52   3 2       2
 5 59   3        32   3 1
 5 22   3    22  64   3 1
 5 60   3        32   3 1
 5 23   3    23  56   3 1
 5 24   41   24  60   3 2
 5 61   4        36   3 1
 5 25   4    25  48   3 1
 5 62  25        30   5 3                                                  34   1
 5 99  25         5   5 2                                                       1
 7  1   31  400
 7  1   34   25
 7  1   37  275
 7  1   42  275
 7  1   46   25
 7  1   49   50
 7  1   52  250
 7  1   17   25
 7  1   56   60
 7  1   19   15
 7  1   57   40
 7  1   19   10
 7  1   58   30
 7  1   20   20
 7  1   21   25
 7  1   59   75
 7  1   22   25
 7  1   60  100
 7  1   23   75
 7  1   24   50
 7  1   61  100
 7  1   25   50
12       1    1    1  100
12       1    2    1  100
12       1    3    1  100
13  1    1  13    150       5 3
15  1    1  30   30    5   99    3   60  190    1
15  2    1  120             50                          4
16  1    1 190   24    2   30    0   50   50   015  0
16  1    2 180   24    2   30    0   50   50   015  0
16  1    3 190   24    2   30    0   50   50   015  0
17  1    1    2    0    1    1    0    0
17  1    2    2    0    1    1    0    0
17  1    3    2    0    1    1    0    0
17  1    4    2    0    1    1    0    0
18  1 6    6    6    6    6    6    6    6    6    6    6    6    6    6
18  2 6    6    6    6    6    6    6    6    6    6    6    6    6    4

         1         2         3         4         5         6         7         9
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Fig. 10 — Sample problem data set (cards 5-18)

```
20  1   1     38   40
20  2   1     38   40
20  3   1     39   40
21  1     1 2828 1616 12     1 4
21  1     2 1918 1010  8     2 2
21  1     3 1616 1010  6     3 2
21  1     4  6 6  4 4  2     4 2
21  1     5 12099 6060 60    5 4
21 99     1    2
21 99     1    3
21  4     1 1616 1010  6     1 4
21  4     2 1010  6 6  4     2 2
21  4     3  9 3  5 5  3     3 2
21  4     4  4 4  2 2  2     4 2
22  1     1  3 3  3 1    2   1 1  1 1
22  2     1  3 3  3 1    2   1 1  1 1
22  3     1  3 3  3 1    2   1 1  1 1
22  4     1  2 2  2 1    2   1 1  1 1
232 1     1101  101  101  101  101  101  101  101  101  101  101
232 1    11101  101  101  101  101  101  101  101  101  101  101
232 1    21101  101  101  101  101  101  101  101  101  101  101
232 4     1101  101  101  101  101  101  101  101  101  101  101
232 4    11101  101  101  101  101  101  101  101  101  101  101
232 4    21101  101  101  101  101  101  101  101  101  101  101
23 72     1    1    0    0    0    0
23 72     2    1    0    0    0    0
23 72     3    1    0    0    0    0
23 70     1    2    1   36   60   79   96   96   10   10   12
23 70     2    2    1   36   60   79   96   96   10   10   12
23 70     3    2    1   36   60   79   96   96   10   10   12
23 70     4    1    1    0                 96  120   15   15   12
23 76     1    2
23 76     1    3
23 99     1  999  999  999  999  999  999  999  999  999  999
23 99    11  999  999  999  999  999  999  999  999  999  999
23 99    21  999  999  999  999  999  999  999  999  999  999
24  1     132000
24  2     132000
24  3     132000
27        130000     230000     330000     430000
29  1   11   21   31   41   51   61   71   81   91  101
29 11  111  121  131  141  151  161  171  181  191  201

          1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Fig. 11 — Sample problem data set (cards 20-28)

```
29  1     1    1     1     0     2     3     4    26    29    62     0     0
29  2     1    1     1     0     2     3     4    26    29    62     0     0
29  3     1    1     1     0     2     3     4    26    29    62     0     0
31        9   12     1     4  6000     1
31        9   12     1     4  6000     1
31        9   12     1     4  6000     1
32        1    4  1 9     4     1  1 9
32        2    4  1 9     4     2  1 9
32        3    4  1 9     4     3  1 9
32        1    4   115    4     1   115
32        2    4   115    4     2   115
32        3    4   115    4     3   115
32        1    4   121    4     1   121
32        2    4   121    4     2   121
32        3    4   121    4     3   121
33        1    4     0    0     2     0   100    4     1     0     0     2     0   100
33        2    4     0    0     2     0   100    4     2     0     0     2     0   100
33        3    4     0    0     2     0   100    4     3     0     0     2     0   100
33        5    6     0    0     2     0   100    6     5     0     0     2     0   100
34  1     1  120     9
34  2     1  120     9
34  3     1  120     9
34  4     1  100     9
41  1 1  36  2
41  2 1  36  2
41  3 1  36  2
43        3  100     0
44  1     1  200   200   200   200   200     0     0     0     0     0     0     0
44  1     2    0     0     0     0     0     0     0     0     0     0     0     0
99
                                                  **** ENTER 1 TO LIST TYPE N
50  1     1    1     1     1   100     4     3    12     0      600     9   000
50  2     1    1     2     1   100     4     3    12     0     1200     9   000
50  3     1    1     3     1   100     4     3    12     0     1800     9   000
50  4     2    1     1     1   100     4     3    12     0      600     9   000
50  5     2    1     2     1   100     4     3    12     0     1200     9   000
50  6     2    1     3     1   100     4     3    12     0     1800     9   000
50  7     3    1     1     1   100     4     3    12     0      600     9   000
50  8     3    1     2     1   100     4     3    12     0     1200     9   000
50  9     3    1     3     1   100     4     3    12     0     1800     9   000
99 30

         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

Fig. 12 — Sample problem data set (cards 29-50)

Card Type #2/1 calls for substantial daily output (PRINT = 14) with cumulative shop statistics to be printed every five days (CUMSTA = 5). The first ten entries on Card Type #2/2, which control the several random number streams that may be repeated exactly on each trial, keep the same sequence.

Card Type #3/1 indicates that combat operations will be conducted from three forward operating units, and that unscheduled maintenance tasks are to be deferred when they are not essential for the designated mission (POSTPN = 1), but are not to be forgotten (IGNORE = 0). Battle damaged tasks are to be completed prior to other unscheduled maintenance (CONCUR = 0). Parts may be cannibalized from vehicles that already have a part missing, whether or not a reparable of the type required is at the unit (CANMOD = 2). Cannibalization may not remove over 20 parts from any vehicle (MXHOLE = 20).

Card Type #3/2 designates many of the policies that are to be used to manage the transfer of vehicles. Whenever a vehicle is transferred to the FAST for mandatory maintenance, all other required tasks, as well as all deferred tasks, are scheduled for completion at the FAST as well (JOBCON = 3).

Card Type #3/3 designates that the parts are to be initialized at the units designated with the #23/70 Type Cards (OUTFIT = 1) and that combat PLLs are to be provisioned so as to provide 30 days of supply. (PMODE = 0). Card #4/1 specifies that crewmen must have a minimum of six hours of sleep each day and that they must be able to rest for at least 30 minutes between missions. The combat maneuvering is expected to be largely completed by 2100Z each day (ENDAY = 21), and deferred maintenance may be initiated after that hour. To initiate such maintenance, the nominal task completion time must be no later than 0400Z (LSTTOD = 400), at which time munitions loadings that have been delayed should be initiated; otherwise delayed loadings should start at 0015Z (LOADTM = 015). Two hours overtime (OVERTIM = 120) is permitted if it is required to complete unscheduled maintenance tasks or munitions assembly jobs. No parts may be cannibalized from any vehicle that has an estimated ready-to-go time within eight hours.

Card Type #4/2 indicates that no projections of each unit's mission-generation capability will be prepared and transmitted to the corps or theater manager (STATE = 0).

TASK DESCRIPTIONS

The most difficult data preparation chore for AURA is developing the data that define what jobs need to be done, how often, what resources are required for their accomplishment, and how long they would be expected to take. Card Types #5 (#6), #8 (#9), #10, #11, #13, #14, and #38 are used to enter these data for unscheduled vehicle maintenance, parts repair, equipment repairs, munitions assembly, reconfiguration and loading, and for the combat engineer facility restoration tasks.

Fifty-three on-vehicle maintenance tasks (Card Type #5) are illustrated in Figs. 9 and 10; most are unscheduled tasks, but one deals with refueling and one with daily inspection. Tasks #31, 34, 37, 42, 49, and 52 lead into task networks. No alternative task procedures are defined.

MISSION AND MUNITIONS DATA

The standard combat loads for the three missions to which Vehicle Type #1 can be assigned are specified with Card Type #12 in Fig. 10. SCL #1 is the preferred load for all three missions. Resource requirements for loading the munitions are specified with Card Type #13. Card Types #15 and #16 specify the various data that define operational factors for Vehicle Type #1 and for the vehicle's three missions that make up the SOC against which these units are being measured. Special unit information, shift schedules, and task incompatibility data are entered on Card Types #17, #18, and #19.

UNIT RESOURCES

The resources available at each unit at the beginning of the simulation are defined with Card Types #20 thru #27. When the resources at two or more units are the same, in part or in total, the features described in Section XIX can be used to reduce the required number of card images.

The initial numbers of vehicles and crews allocated to each unit are specified in Fig. 11 on the Type #20 Cards. Thirty-eight Type #1 Vehicles and 40 crews are at each of the three forward operating units. Their initial mission configuration is shown on the Type #41 Card in Fig. 12 as 36 ready for Mission #1 and the remainder for Mission #2, which are respectively the first and second missions scheduled for the first day of operations. Vehicles may either be ready at zero time as shown here, or undergoing unscheduled maintenance, by means of Type #42 Cards.

Unit maintenance personnel are established with the Type #21 Cards shown in Fig 11. Each forward operating unit has 28 tracked vehicle mechanics, 18 electricians, 16 armament technicians, six recovery vehicle drivers, and 120 crewmen. Because these units have identical numbers of personnel, the #21/88 Type Card is used to duplicate the personnel at Unit #1 for Units #2 and #3. The FAST (Unit #4) has 16 tracked vehicle mechanics, ten electricians, eight armament technicians, and four recovery vehicle drivers. Support equipment stocks are specified with #22 Type Cards. Three recovery vehicles and one A-frame are on hand at each forward operating unit; as with personnel, support equipment at Units #1, #2, and #3 are identical. The FAST has two recovery vehicles and one A-frame.

The initial base stocks of spare parts may be entered for each base using Card Type #23, or the user may elect to take advantage of AURA's automatic parts initialization subroutines by using the special Type #23 Card formats; some of these special features are used in this example.

The policy factors that govern (non-battle-damage) spare parts stocks to be laid in at each unit are entered with the #23/70 and #23/72 Type Cards, and the NRTS data and item cost data for each type of part are entered with the #23/20x, #23/30x, and #23/66 Card Types. Note that advantage is taken of the #23/76 Card Type to specify the same NRTS rates at all forward operating units. The DISCOM provides a large reserve of all parts (Type #23/99 Cards).

Initial stocks of assembled and unassembled munitions, accessories, POL, and building materials are indicated on Fig. 12. As indicated with the Type #29 Cards, the same maintenance procedures are to be followed at all units.

SHIPPING AND COMMUNICATION

Only token shipments are scheduled (see Fig. 13) to the theater from CONUS; 6000 rounds of Type #1 Munitions are shipped to each forward operating unit at noon on the ninth day of the simulation. The transportation schedule between the forward operating units and the rear maintenance unit (Card Type #32) specifies that shipments leave the FAST three times daily to each forward unit, and return. Shipment times are two hours with no loss of shipments (Card Type #33).

MISSION DEMANDS

Only one of the several options that are available for specifying mission demands have been used in this sample data base. Each Type #50 Card shown in Fig. 12 calls for nine platoons of four vehicles to be committed to combat three times daily from each battalion-sized unit. The first card calls for nine platoons from Unit #1 to be sent on Mission #1 at 0600. The unit has a twelve hour notice of these demands, and a platoon of three vehicles is acceptable if a four-vehicle platoon can not be assembled. These demands occur daily at each of the three units.

XXI. OUTPUTS FOR SAMPLE PROBLEM

As explained in Section XV, AURA provides the user a variety of output options. This section will illustrate some of those options with reproductions of the results for the sample problem developed in the preceding section.

Figure 13 displays the formatted title page that summarizes the user-selected values for many of the control variables. As noted at the top, a 15-day simulation is to be run for a total of five trials. Three task-force size units and one FAST are involved in the simulation. A variety of other control variables are recorded in the upper and center sections of this page. Key array dimensions are listed at the bottom. As noted earlier, the user has two options to control the reproduction of input data. He may specify that some, or all, of the input card images be reproduced directly, or he may direct that the input data are to be listed after they have been formatted for the storage arrays. A "1" in the tens column of the PRINT variable means that the initial Type #50 Cards will be displayed.

Figure 14 illustrates a typical end-of-day report for day 2 of Trial #1. A total of 114 vehicles remain at all units with none having been lost in combat or as a result of enemy air/artillery attacks; none have sustained battle damage during the two days of operations. Of the 114 vehicles, four are at the FAST, two of which come from Unit #1 and two from Unit #2. This can be seen by examining the number of vehicles cumulatively withdrawn to the FAST for maintenance by each unit and those cumulatively returned to each forward operating unit.

At these forward operating units, 252 vehicles were committed to combat (i.e., sent on missions) during the second day. The number of platoons committed to combat and the number demanded (nine per task force for each of the three missions that day) are shown next. The first four columns refer to Unit #1, the next four to Unit #2, and so on. The FAST naturally, does not commit vehicles to combat.

The number of vehicles committed to combat by unit and mission type follows, along with the number demanded and the ratio of committed to demanded. Usually the number of vehicles committed equals the number of

```
                                                                                    JANUARY  27, 1983   02:0( AM

                                        ARMY UNIT READINESS/SUSTAINABILITY ASSESS

                                            ADAPTED AT THE RAND CORPORATION
                                             FOR THE DEPARTMENT OF THE ARMY
                                        BY D. F. EMERSON, R. SHISHKO, P. KAMENS AND P. BERGER

  UNITS : OPERATING 3  OTHER 1                SIMULATION LENGTH  15 DAYS                NUMBER OF TRIALS   5                EXTEND 0
                                                                                                                        PROBE  0
                                                                                  DEPTH PARTS 1  SHORTAGE  0%   PIPELINE 1  RANDM 0
ORDER INTERRUPTED TASKS     0          INITIAL VEHICLE     114          CANNIBALIZATION MODE          2
ORDER WAITING TASKS         0          INITIAL CREWS       120          LEAST DOWN TIME TO CANN       8 HRS
DEFER NON-CRITICAL TASKS    1                                           CANN TIME IS  150% NOMINAL PLUS  15 MIN DELAY
REPAIR SEPARATELY           0          SEED                  1          MAX HOLES PER VEH  20      "RDCANN" 10000
OVERFLOW CONTROL            2          TRIAL   0    TEST  0 (     0     0)   CANN SPARES         0
     ACTIVE MANEUVER DAY    21:00      MISSION INPUT HOUR          20:00   CREWMEN SLEEP  6 HRS          PRINT            11
    COMMENCE LOADING (NOM)   0:15      ALLOWABLE OVERTIME          120 MIN  REST TIME      30 MIN         VERIFY            1
                    (LAST)   4:00                                           REPORTS        0 (  15)       DELAY DATA        5 DAYS
                                                                           START REPORTS 0.0 DAYS          STORE STATISTICS  0
    ASSEMBLE MUNITIONS      0          BREAK-RATES: UNCER  0  VARIABLE 0    IGNORE DEFERRABLE TASKS  0    PRINT PARTS      28

                        SHIFTING DATA                                                  BIVOUAC ATTACK FACTORS
                        *************                                                  **********************

CONUS SHIPMENTS          200(2500)      RESUPPLY SHIPMENTS      2000        FACILITIES/UNIT 100          REBUILD          0
THEATER SHIPMENTS                                                           CE PERSONNEL      0          ATTACKS         40
     PREPARATION TIME    0 MIN              DAILY NOMINAL        10        CE EQUIPMENT      0          DAMAGE DATA 2000
     MAXIMUM DAMAGES 2500                   MAXIMUM             100        CE MATERIALS     25          CRIT BDG #      0
                                            MAXIMUM STORAGE     400        CE DELAYS       180 MIN     SHOP DELAYS  180 MIN

                                                    RESOURCE MANAGEMENT
                                                    *******************
                                                  THEATER CONTROL MODE   10
THEATER MANAGEMENT       0      INITIAL REVIEW TIME 1600 HRS      CONCURRENT DAMAGE REPAIR   2      EXPEDITE PARTS REPAIR    0
AURA CONTROL MODE        1      REVIEW INTERVAL      500 HRS      CREW MAINTENANCE CREWS     3      SHIP PARTS WHERE NEEDED  0
CRF PRIORITY THRESHOLD   3      REVIEW POLICY          0          FILLER CONTROL             0      ER PARTS NRTS THRESHOLD  0%
AURA ORDER THRESHOLD     0      UNIT ORDER THRESHOLD   0          FILLER LEVEL               0      SHIP IF SHOP DAMAGED     0
PRIORITIZATION MODE      0      CONSIGN PARTS          0          FILLER CALL THRESHOLD    0.0 HRS  SHIP IF SPR NOT STOCKED  0
ASSESS UNIT STATE        0      SELECT RECOVERY UNIT   0          VEH ROTATION THRESHOLD 100.0 HRS  HOLD REPARABLE TO SHIP   0
                                                                                  (     1   100)

                                                    DIMENSIONS OF STORAGE ARRAYS
                                                    ****************************

VEHICLES  400                  PERSONNEL TYPES 200              TASKS        1000                  REPAIRS        250
VEH CREWS 800                  PARTS          1000              INTERRUPTED   400                  WAITING       2000
UNITS       8                  EQUIPMENT       100              REQUIRED     2500                  DEFERRED      4000
VEH TYPES   2                  MUNITIONS        25              ADMIN DELAY  1000                  DEADLINES     2000
MISSIONS    4                  ACCESSORIES      25              INCOMPATIBLE   40                  MISSIONS       400

TASK TYPES  1000        REPAIR TYPES1000        FOR REPAIRS  100          OF CREWS   20          STANDARD COMBAT LOADS  30
ALTERNATES   200        ALTERNATES   200        AMMO ASSEMBLY 30          OF TASKS  400          CONFIGURATIONS         30
```

Fig. 13 — Sample problem outputs (simulation variables)

COMPUTER TIME: 6.255 SEC

DAY 2 TRIAL # 1 TOTAL VEHICLES 114 (0 0)
VEHICLES BY UNIT 36 36 38 4
VEHICLES WITHDRAWN/SENT FORWARD BY UNIT 7/ 5 10/ 8 5/ 5
VEH.COMM: DAILY TOTAL 252 CUMULATIVE: TOTAL 524

	BY UNIT:	174	173	177	0								
PLTNS/TOBES	COMM	9	7	6	0	9	7	6	0	9	7	6	0
	DEMANDED	9	9	9	0	9	9	9	0	9	9	9	0
EFFECTIVENESS		32	28	23	0	31	27	24	0	35	28	24	0
VEHICLES	COMM	32	28	23	0	31	27	24	0	35	28	24	0
	DEMANDED	36	36	36	0	36	36	36	0	36	36	36	0
	FRAC	.89	.78	.64	.0	.86	.75	.67	.0	.97	.78	.67	.0

PERCENT VEHICLES REARIED IN "N" HOURS (CUM)

2 HR:	27	27	27
4 HR:	76	72	73
6 HR:	87	78	79
9 HR:	89	79	92

MISSIONS INITIATED DURING HOUR ENDING AT:

UNIT	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00
1	0	0	0	0	0	32	0	0	0	0	0	29	0	0	0	0	0	23	0	0	0	0	0	0
2	0	0	0	0	0	31	0	0	0	0	0	27	0	0	0	0	0	24	0	0	0	0	0	0
3	0	0	0	0	0	35	0	0	0	0	0	28	0	0	0	0	0	24	0	0	0	0	0	0

SHOPS ON UNIT 1 (VEHICLES 36 BATTLE DAMAGED: CURRENT 0 TOTAL 0)

SHOP NO	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25				
ON-VEHICLE	22	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	(	0)		
MAN HOURS(X10)	4	0	2	5	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	8	0
OFF-VEHICLE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(	0	0)	
MAN HOURS(X10)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SHOP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	27	28	29	30
TASKS	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	6	
REPAIRS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				0
TASKS WAITING	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	2	0	0
TASKS INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
REPAIRS WAIT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
REPAIRS INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				

Fig. 14 — Sample problem outputs (end-of-day report)

platoons times platoon size except when the user permits understrength platoons to be committed by a unit, e.g., three vehicles instead of the normal four.

The rates at which vehicles have been made ready for another combat mission are indicated for each forward operating unit. At Unit #1, for example, 27 percent of the vehicles were reconstituted within two hours and 76 percent within four hours of the time they arrived at the task force bivouac area from their last mission. The hourly record of mission generation, i.e., vehicles committed to combat on a given mission, is shown next. These data are sometimes useful in determining how many vehicles had late "jump off" times.

The shop status reports shown next include not only the current activity but also the totals of the on-vehicle, off-vehicle, and support equipment repair jobs that were completed during the preceding 24 hours, and the cumulative numbers of manhours expended in each shop. The number in parentheses at the right end of the on-vehicle task line is the cumulative number of parts cannibalization actions; in this case none occurred at Unit #1. The two numbers in parentheses at the right end of the off-vehicle line are, first, the cumulative number of LRUs that have been cannibalized to obtain an SRU, and second, the cumulative number of repairs that have been expedited; in this case, none again.

On-vehicle tasks currently being performed, as well as those waiting and interrupted, are indicated next. Parts repair (not considered in this sample problem) on-going, waiting, and interrupted are also displayed. A negative entry for on-going repairs is actually a record of the damage level at that shop from enemy air/artillery attacks; the minus sign signals that this is the appropriate interpretation. Identical information is provided for all the remaining units including the FAST, if included in the simulation.

Figure 15 illustrates a typical end-of-trial report. Platoons and vehicles committed to combat over the entire period of operations are shown along with the cumulative demands. Cumulative number of on-vehicle and off-vehicle tasks by shop and unit are also displayed.

More accurate and specific indications of resource constraints are provided by the data listed in Fig. 16. This figure summarizes the cause and the extent of all vehicle maintenance and supply delays. Each

```
                              FINAL RESULTS   TRIAL #  1

                           SURVIVING VEHICLES  114

  994    PLNS/TUBES 132 109  95   0 132 108  93   0 132 105  88   0
 1215       DEMANDED 135 135 135   0 135 135 135   0 135 135 135   0

 3942 EFFECTIVENESS 524 433 376   0 522 427 371   0 524 416 349   0

 3947 VEHICLES COMM 524 433 376   0 527 427 371   0 524 416 349   0
 4860       DEMANDED 540 540 540   0 540 540 540   0 540 540 540   0
0.811          FRAC  .97 .80 .70 .0  .97 .79 .69 .0  .97 .77 .65 .0

                 MISSION STATISTICS FOR PRIORITY # 1
 3942    ACHIEVED   524 433 376   0 522 427 371   0 524 416 349   0
 4860    DEMANDED   540 540 540   0 540 540 540   0 540 540 540   0
 0.81       FRAC     .97 .80 .70 .0  .97 .79 .69 .0  .97 .77 .65 .0
                                  SHOPS ON UNIT  1     (VEHICLES  31          BATTLE DAMAGED:  CURRENT   0     TOTAL   0)
 SHOP NO          1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24   25
ON-VEHICLE      350  32  47  32   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0  512  (  0)
OFF-VEHICLE       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0    0  (  0   0)
                                  SHOPS ON UNIT  2     (VEHICLES  30          BATTLE DAMAGED:  CURRENT   0     TOTAL   0)
 SHOP NO          1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24   25
ON-VEHICLE      314  37  57  37   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0  506  (  0)
OFF-VEHICLE       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0    0  (  0   0)
                                  SHOPS ON UNIT  3     (VEHICLES  34          BATTLE DAMAGED:  CURRENT   0     TOTAL   0)
 SHOP NO          1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24   25
ON-VEHICLE      314  39  84  38   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0  514  (  0)
OFF-VEHICLE       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0    0  (  0   0)
                                  SHOPS ON UNIT  4     (VEHICLES  19          BATTLE DAMAGED:  CURRENT   0     TOTAL   0)
 SHOP NO          1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24   25
ON-VEHICLE       76  33  23  42   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0  142  (  1)
OFF-VEHICLE       0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0    0  (  0   0)

          CUMULATIVE DEADLINE-HOURS BY UNIT       0       0       0     135

                  ALL STORAGE QUEUES WERE ADEQUATE FOR TRIAL  1

       QUANTITIES AND TIMES FOR ON-VEHICLE TASKS AT UNIT 1

   SHOP          1     2     3     4    25    28    29
  NUM TASKS    350    32    47    32   512  1468  1376
AVG TIME-HR    1.9   0.7   2.1   2.0   2.0   0.9   1.1
STAN DEV-HR    1.9   0.4   0.8   0.5   0.6   0.5   0.9
MAN HRS X10     30     2    16    40     0   286    68
STAND. TIME    1.4   1.2   2.1   2.2   1.5   0.0   0.0
```

Fig. 15 — Sample problem outputs (end-of-trial report)

VEHICLE DELAYS DUE TO RESOURCE LIMITATIONS

****

UNIT 1

DELAYS DUE TO LIMITATIONS OF PERSONNEL

TYPE	4	5
NUM DELAYS	33	988
AVG DELAY-HR	3.0	0.9
STAN DEV-HR	1.8	0.4

DELAYS DUE TO LIMITATIONS OF EQP

TYPE	2
NUM DELAYS	42
AVG DELAY-HR	1.6
STAN DEV-HR	1.0

DELAYS DUE TO LIMITATIONS OF MUNITIONS

TYPE	1
NUM DELAYS	4
AVG DELAY-HR	4.3
STAN DEV-HR	0.7

UNIT 2

DELAYS DUE TO LIMITATIONS OF PERSONNEL

TYPE	4	5
NUM DELAYS	21	932
AVG DELAY-HR	2.3	0.8
STAN DEV-HR	0.8	0.5

DELAYS DUE TO LIMITATIONS OF EQP

TYPE	2
NUM DELAYS	29
AVG DELAY-HR	2.6
STAN DEV-HR	3.1

UNIT 3

DELAYS DUE TO LIMITATIONS OF PERSONNEL

TYPE	4	5
NUM DELAYS	26	926
AVG DELAY-HR	2.6	0.8
STAN DEV-HR	1.2	0.5

DELAYS DUE TO LIMITATIONS OF EQP

TYPE	2
NUM DELAYS	57
AVG DELAY-HR	1.9
STAN DEV-HR	1.7

UNIT 4

DELAYS DUE TO LIMITATIONS OF PERSONNEL

TYPE	2	3	4	5
NUM DELAYS	2	23	2	269
AVG DELAY-HR	0.9	4.2	1.1	4.9
STAN DEV-HR	0.2	3.7	0.3	5.1

DELAYS DUE TO LIMITATIONS OF EQP

TYPE	2
NUM DELAYS	4
AVG DELAY-HR	1.3
STAN DEV-HR	1.0

DELAYS DUE TO LIMITATIONS OF PARTS

(ALSO, REPAIR DELAYS DUE TO SRUS)

HOLES 1 HOLES/VEH 0.053 HOLES PER D/L VEH. 1.000 HOLES/DEADLINE 1.000

TYPE	13	14	18	25	26	29
SHOP	1	1	2	4	1	1
NUM DELAYS	1	1	1	1	2	1
AVG DELAY-HR	24.0	24.0	24.0	5.9	15.6	24.0
STAN DEV-HR	0.0	0.0	0.0	0.0	8.4	0.0
VEH "HOLES"	0	0	0	1	0	0

Fig. 16 — Sample problem outputs (resource limitations report)

type of maintenance personnel, support equipment, etc. for which a shortage caused an on-vehicle task to be delayed is recorded. These statistics provide an excellent indication of the bottlenecks and obvious indications of where extra resources could be of help in improving each unit's mission-generation capabilities. In this instance there were delays for recovery vehicle drivers and crewmen at Unit #1 that averaged 3 hours and 0.8 hours, respectively. A greater number of these MOSs clearly would have reduced the backlog of work.

The status of spares at each unit is also available; the number of in-unit serviceables and reparables are listed for each part type. The total number of spares that were removed from vehicles during the simulation is also shown for each unit.

Figure 17 illustrates the summary data provided at the completion of the specified number of trials. Data include the average number of vehicles committed to combat each day at all operating units, as well as the average number of vehicles committed of each mission type at each unit; the standard deviation is also listed in the latter case. As before, the first four columns refer to Unit #1, and so on. The output is concluded with records of the average number of vehicles committed to combat throughout the simulation for each mission type and each unit, as well as at all units. These data are useful in calculating the readiness and sustainability indexes described in R-2769-MRAL (see Preface).

OVERALL PERFORMANCE IN 5 TRIALS

VEHICLES COMMITTED - DAILY TOTAL AND MEAN AND STANDARD DEVIATION BY MISSION AND BY UNIT

DAY	TOTAL											
1	269.6	36.0	27.6	25.2	0.0	36.0	29.4	24.6	0.0	36.0	29.2	25.6	0.0
		0.0	2.2	1.9	0.0	0.0	1.7	1.2	0.0	0.0	1.9	1.7	0.0
2	258.4	33.4	25.6	24.0	0.0	33.0	27.0	26.4	0.0	34.0	28.6	26.4	0.0
		2.2	3.2	1.5	0.0	1.7	1.5	2.0	0.0	2.1	1.2	3.2	0.0
3	255.6	32.8	26.6	22.2	0.0	35.0	26.4	23.6	0.0	36.0	28.6	24.0	0.0
		3.0	1.4	2.2	0.0	1.5	3.2	3.6	0.0	0.0	2.8	4.4	0.0
4	260.6	34.4	29.0	24.4	0.0	35.4	28.2	24.6	0.0	34.0	27.0	23.6	0.0
		2.0	3.0	3.8	0.0	0.5	4.8	3.8	0.0	1.7	3.2	0.5	0.0
5	260.2	34.0	28.2	26.2	0.0	34.2	28.2	23.8	0.0	35.6	27.8	22.2	0.0
		1.7	1.5	2.8	0.0	1.8	2.6	3.4	0.0	0.5	3.4	1.8	0.0
6	261.6	33.4	29.2	24.4	0.0	34.6	28.8	25.4	0.0	34.8	26.2	24.8	0.0
		1.7	1.5	1.9	0.0	1.4	1.6	1.7	0.0	1.5	3.8	3.0	0.0
7	248.4	35.0	26.0	23.6	0.0	33.6	26.2	22.8	0.0	32.8	26.8	21.6	0.0
		1.5	2.1	5.1	0.0	2.0	2.2	2.6	0.0	1.6	2.6	3.2	0.0
8	261.6	36.0	27.0	23.8	0.0	35.6	28.4	25.4	0.0	33.4	27.0	24.0	0.0
		0.0	3.0	2.6	0.0	0.5	1.7	4.0	0.0	1.7	1.5	3.6	0.0
9	261.6	34.2	27.6	22.2	0.0	34.8	28.4	25.4	0.0	35.0	28.6	24.4	0.0
		1.8	2.8	4.0	0.0	1.5	1.7	1.7	0.0	1.5	2.8	1.8	0.0
10	263.8	34.8	28.8	25.4	0.0	34.4	27.6	24.8	0.0	35.8	27.8	23.4	0.0
		1.5	1.8	2.2	0.0	2.0	3.4	1.6	0.0	0.4	2.6	2.2	0.0
11	261.0	34.2	27.0	25.0	0.0	35.0	27.6	23.8	0.0	35.2	28.4	24.8	0.0
		1.8	3.0	4.7	0.0	1.5	3.8	3.6	0.0	0.4	3.6	1.6	0.0
12	263.2	35.2	28.8	25.4	0.0	34.8	25.6	26.2	0.0	34.8	29.4	23.0	0.0
		1.6	3.0	4.5	0.0	1.5	2.0	3.4	0.0	1.5	2.2	1.5	0.0
13	259.6	34.6	26.2	24.0	0.0	34.8	27.8	24.6	0.0	34.4	27.8	24.4	0.0
		1.4	1.8	2.5	0.0	1.5	0.4	4.7	0.0	2.0	2.6	2.6	0.0
14	254.0	33.6	26.4	23.6	0.0	35.2	26.2	22.0	0.0	35.0	27.6	24.4	0.0
		2.0	2.8	4.8	0.0	1.6	3.4	2.1	0.0	1.5	3.6	3.4	0.0
15	248.8	34.0	27.0	21.4	0.0	34.6	26.2	20.8	0.0	34.2	27.2	23.4	0.0
		1.7	1.5	1.7	0.0	1.8	3.8	6.8	0.0	1.8	1.6	5.1	0.0
TOTALS		515	411	360	0	520	414	364	0	520	417	359	0

AVERAGE VEHICLES COMMITTED PER TRIAL 3887.0

Fig. 17 — Sample problem outputs (overall performance report)

XXII. CHECKING FOR DATA SET CONSISTENCY

AURA was designed to enable the user to pose a large number of "what if" questions. Many of these can be handled by making one or a few seemingly simple changes in the input data, but because AURA is a complex model, the user should exercise care when making such changes in proven data sets. To maintain the necessary internal consistency of a data set when new simulation conditions are desired, the user must check carefully to ensure that the impact of a change in one part of the data set is adequately reflected in other parts that interact with it. Such inconsistencies are particularly likely when the user attempts to use a data set that has been derived (i.e., patched together) from a collection of previously successful input data sets. To help avoid some of these problems, this section gives a few examples of links between card types that should be noted when making changes. These examples are not a complete list.

CROSS TRAINING

The use of this option would allow a particular type of maintenance personnel to perform work normally associated with a different type of person or to assist in the performance of that task. A "1" must be placed in column 25 of the Type #17 Card to indicate the unit has cross-trained personnel. The tasks must be identified by placing a "1" in column 79 of the Type #5 Cards, in columns 30, 55, and 80 of the Type #11 Cards, and in columns 15 and 35 of the Type #13 Cards on which the particular task appears. The personnel types so cross-trained must be identified on a Type #45/2 Card if they can replace the original type, or on a #45/3 Card if they can assist the original type. Caution should be exercised in the interpretation of the output when this option is used as delay times will be accrued to the "home" shop of the cross-trained individual, should work be waiting there, even if he is active in his secondary capacity. The time spent in working at a shop, however, is logged against that shop without indicating that the work was done by a visitor.

PARTS REPAIR

The user may wish to see the effect of changing the condemnation rate, the NRTS rate, or the probability of some repair alternative. For each part, unless a Card Type #5 entry shows in columns 68-70 that it is always condemned, or a Card Type #23 shows it is never repaired anywhere in the simulation, i.e., a 100 percent NRTS rate at every unit, the user must provide repair information on the Type #8 Card and routing information on the Type #34 Card. A part that is "NRSTed" to another unit, e.g., a FAST or DISCOM, will be sent to the lowest echelon of maintenance at which the NRTS rate is less than 100 percent; the part will bypass any echelon of maintenance that is unable to effect the repair, regardless of the routing data on the Type #34 Card. The user should also check that if the repair of a part is permitted at a unit not previously assigned that task, the resources required for that job are recognized on the Type #21, #22, and #23 Cards.[1]

When changing task probabilities, the user must ensure that the sum of probabilities of a set of mutually exclusive tasks is unity. This applies to repair alternatives on the Type #8 Card as well as networks on the Type #5 Card, whose task probabilities are preceded by a minus sign in columns 36-39.

VEHICLE NUMBERS, CONFIGURATIONS, AND MISSIONS

The user may wish to make a number of changes regarding the number of vehicles at a unit, or the number of vehicles to be committed to combat at a certain time. Because AURA keeps track of vehicles individually, information on vehicles must not conflict from one card type to another. For example, if a unit has 54 tanks of a given type, as shown on the Type #20 Card, then the sum of tanks in various initial configurations on the Type #41 Card must also be 54. Changing the

[1] If the personnel type for a particular task is not present at a unit, the AURA's data editor will upon initialization uncover that fact and stop the the simulation with an appropriate message. However, missing support equipment will not be flagged by the current AURA software. Further, the user must also check that repair team sizes indicated on the Type #20 Card do not exceed the maximal shift assignments, as this will not stop the simulation either. The user will first discover these "missing resources" by observing that these jobs fail to process through otherwise "idle" shops.

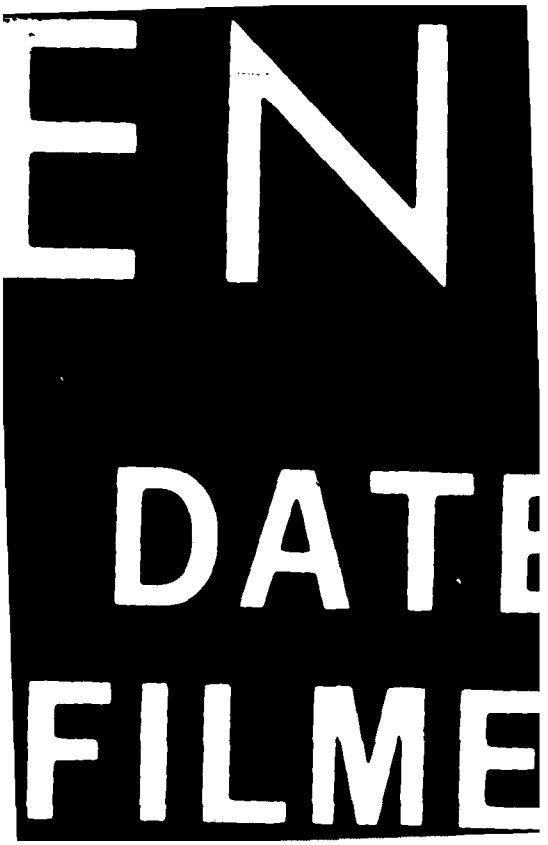
number of vehicles at a unit requires changing the initial configuration mix as well. Changing the number of vehicles to be committed to combat on the Type #50 Cards without changing the initial configuration mix may also lead to anomalies as the unit may be unable to respond fully early in the simulated period of operations.

SHIFTING UNIT POSTURE

Perhaps the most complex of the more common data set changes occurs when the user wishes to shift a large set of units from a series of defensive operations to a series of offensive operations or vice versa. Changes to the Type #50 Cards are probably the most self-evident, but several other card types may be affected as a consequence. If attrition parameters are different, as is likely, then several entries on the Type #16 Card must be changed, as well as those Type #5 Card entries that treat battle damage. Any difference in mission duration requires a change in the Type #16 Card, and possibly in the task probability modifiers on the Type #44 Card, should mission mileage and/or firing rates change. If mission mileage does in fact change, then it is likely that the user would want to modify the refuel quantity in columns 21-25 of the Type #15/1 Card. If firing rates change, then the user must change the primary munition quantity in columns 19/20 of the Type #13 Card and the secondary munitions quantities, if appropriate, also on the Type #15/1 Card.

Card Type #41 should now show the number of vehicles configured for the new first mission, which is on the revised Type #50 Cards. Should resupply rates be different due to changes in consumption, LOC distances, or logistic sources, the user must reflect these in Card Types #31 and #43. Personnel and support equipment realignments should be reflected in Card Types #21 and #22 respectively. Should the FAST or DISCOM be required to move on a different schedule, changes are required in Type #40 Card for the "shutdown" time, and to the SHPDLY parameter on the Type #4/1 Card, if the time spent moving differs.

The changes mentioned in this subsection are not meant to be exhaustive, but only to relect recent experience. The user may well identify other changes to the input data set that are necessary to perform his desired simulation.


EN
DATE
FILME